PROCEEDINGS

OF THE

BOARD OF AGRICULTURE IN INDIA

HELD AT

CAWNPORE

ON THE

16th February, 1907, and following days.

WITH APPENDICES.

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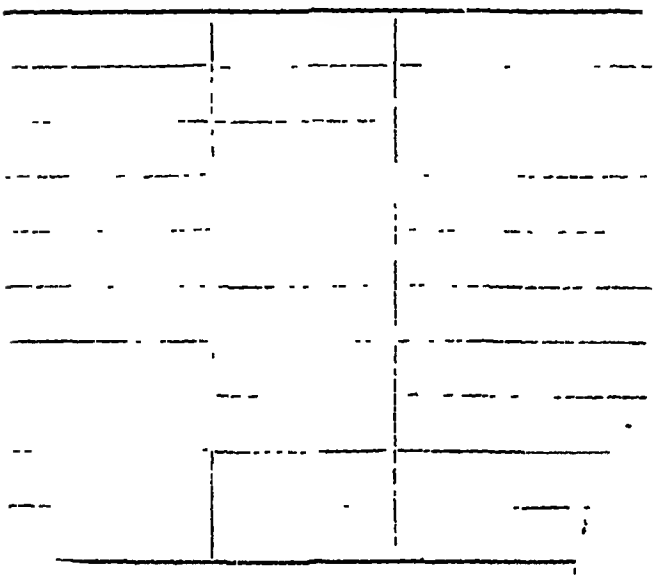

PROCEEDINGS

OF THE

BOARD OF AGRICULTURE IN INDIA

HELD AT

CAWNPORE

ON THE

18th February, 1907, and following days.

WITH APPENDICES.

CALCUTTA:

OFFICE OF THE SUPERINTENDENT OF GOVERNMENT PRINTING, INDIA.

1907.

CALCUTTA:
GOVERNMENT OF INDIA CENTRAL PRINTING OFFICE:
8, HASTINGS STREET.

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No. C.—13, dated Camp Cawnpore, the 24th February 1907.

From—F. G. Sly, Esq., I.C.S., Offg. Inspector General of Agriculture in India,

To—The Secretary to the Government of India,

Department of Revenue and Agriculture.

I have the honour to submit the Proceedings of the Meeting of the Board of Agriculture held at Cawnpore on the 18th February 1907, and succeeding days. These proceedings have been recorded by the Secretary, Dr. E. J. Butler, Imperial Mycologist, Pusa, and have been approved by the Board.

Proceedings of the 3rd Annual Meeting of the Board of Agriculture held at Cawnpore on the 18th February 1907, and succeeding days.

List of Members.

1. F. G. Sly, I.C.S., *Offg. Inspector General of Agriculture in India, President of the Board.*
2. E. J. Butler, M.B., F.L.S., *Imperial Mycologist, Pusa, Secretary to the Board.*
3. Colonel J. W. A. Morgan, M.R.C.V.S., *Inspector General, Civil Veterinary Department.*
4. J. W. Leather, Ph. D., F.I.C., F.C.S., *Imperial Agricultural Chemist, Pusa.*
5. H. M. Lefroy, M.A., F.E.S , F.Z.S., *Imperial Entomologist, Pusa.*
6. C. J. Bergtheil, *Imperial Bacteriologist, Pusa.*
7. E. Shearer, M.A., B. Sc., *Imperial Agriculturist, Pusa.*
8. A. Howard, M.A., A.R.C.S., F.C.S., F.L.S., *Imperial Economic Botanist, Pusa.*
9. W. Roberts, B. Sc., *Supernumerary Agriculturist, Pusa.*
10. G. H. Garrad, N.D.A., *Supernumerary Agriculturist, Pusa*
11. T. F. Main, B. Sc., *Assistant Inspector General of Agriculture in India.*
12. Captain A. T. Gage, I.M.S., M.B., M.A., B. Sc., F.L.S., *Director of the Botanical Survey of India.*
13. F. Smith, B. Sc., *Deputy Director of Agriculture, Bengal.*
14. H. H. Corbin, B. Sc., *Principal of the Agricultural College, Bengal.*
15. W. H. Moreland, B.A., LL.B., C.I.E, I.C.S., *Director of Agriculture, United Provinces of Agra and Oudh.*
16. J. M. Hayman, D.V.S., *Deputy Director of Agriculture, United Provinces of Agra and Oudh.*
17. H. M. Leake, M.A., F.L.S., *Economic Botanist, United Provinces of Agra and Oudh.*
18. A. W. Fremantle, *Principal, Agricultural College, United Provinces of Agra and Oudh.*
19. G. Clarke, F.I.C., *Agricultural Chemist, United Provinces of Agra and Oudh.*
20. Khan Bahadur S. M. Hadi, M.R.A.C., *Assistant Director of Agriculture, United Provinces of Agra and Oudh.*
21. W. C. Renouf, I.C.S., *Director of Agriculture, Punjab.*
22. S. Milligan, M.A., B. Sc , *Deputy Director of Agriculture, Punjab.*
23. A. C. Dobbs, B.A., *Principal, Agricultural College, Punjab.*
24. J. H. Barnes, B. Sc., A.I.C., F.C.S., *Agricultural Chemist, Punjab*
25. P. J. Mead, I.C.S., *Director of Agriculture, Bombay.*

26. F. Fletcher, M.A., B. Sc., *Deputy Director of Agriculture, Bombay*
27. J. B. Knight, M. Sc., *Professor of Agriculture, Agricultural College, Bombay.*
28. G. A. Gammie, F.L.S., *Economic Botanist, Bombay.*
29. A. A. Meggit, B. Sc., *Agricultural Chemist, Bombay.*
30. E. Thompstone, *Assistant to the Deputy Director of Agriculture, Bombay.*
31. M. E. Couchman, I.C.S., *Director of Agriculture, Madras.*
32. R. W. B. C Wood, B.A., *Deputy Director of Agriculture, Madras.*
33. W. H. Harrison, M. Sc., *Agricultural Chemist, Madras.*
34. H. C Sampson, B. Sc., F.H.A.S., F.B.S.E., *Second Deputy Director of Agriculture, Madras.*
35. D. Clouston, M.A., B. Sc., *Deputy Director of Agriculture, Central Provinces.*
36. F. Plymen, A.C.G.I., *Agricultural Chemist, Central Provinces*
37. G. Evans, B.A., *Principal, Agricultural College, Central Provinces.*
38. J. MacKenna, I.C.S., *Director of Agriculture, Burma.*
39. F. J. Warth, M. Sc., *Agricultural Chemist, Burma.*
40. S. G. Hart, I.C.S., *Director of Agriculture, Eastern Bengal and Assam.*
41. Rai Bahadur B. C. Basu, M.R.A.C., *Assistant to the Director of Agriculture, Eastern Bengal and Assam.*
42. R S Finlow, B. Sc., F.C.S., *Fibre Expert to the Government of Eastern Bengal and Assam.*
43. H. H. Mann, D. Sc., *Scientific Officer to the Indian Tea Association.*
44. A. Lehmann, M.A., B.S.A., Ph. D., *Agricultural Chemist to the Government of Mysore.*
45. Raojibhai B. Patel, M.R.A.C., *Director of Agriculture and Industries, Baroda.*
46. L. C. Sharma, M.R.A.C., P.A.S.I., *Bar.-at-Law, Director of Agriculture, Kashmir.*

Visitors.

47. Sir Edward Buck, K.C.S.I., LL.D.
48. Major E. H. Atkinson, R.E., *Principal, Thomason College, Roorkee.*

FIRST DAY.

CONFIRMATION OF THE MINUTES OF THE LAST MEETING.

1. A note was presented by the President showing the action taken on the proceedings of the last meeting of the Board (see Appendix B, page 21). The proceedings of the last meeting held at Pusa on the 15th January, 1906, and succeeding days were confirmed.

THE IMPROVEMENT OF THE INDIAN SUGARCANE INDUSTRY.

2. The main business before the Board being the framing of recommendations for the improvement of the sugarcane industry in India, it was decided to form a sub-committee to consider the reports received from the various provinces (see Appendix H, page 81) and to draft in outline a general scheme for future work. The following terms of reference were made to serve as a general guide to the sub-committee :—

A.—Cultivation.

The testing of varieties, including exotics, and especially the determination of the amount of variation in each variety as a preliminary to improvement by chemical selection. The trial of manures. Improvements in the

methods of cultivation. Improvements in irrigation and drainage. The improvement of ratoons by cultivation. The possibility of raising seedling canes in India. The investigation of disease and pests.

In particular the Committee should carefully consider the best methods for (1) laying out field experiments, (2) determining the quantitative yield of experimental plots, (3) testing on a planting scale the results of experimental station trials, and (4) the equipment necessary, and the maximum area that can be effectively dealt with by that equipment.

B.—Manufacture.

(1) The actual efficiency and the losses which occur at the various stages of the manufacture of *gur* or *jaggery*, and the methods of reducing these losses.

(2) The indigenous processes of sugar manufacture.

(3) The introduction of the small power factory system.

(4) The local conditions necessary for the successful working of the Central Factory System such as (*a*) minimum amount of cane required, (*b*) the radius from which it can be drawn, (*c*) number of cane cultivators to be dealt with, (*d*) supply of cane by cultivators, (*e*) the means of transporting cane to the mill, (*f*) the extension of the reaping period by the cultivation of early or late maturing canes, and (*g*) the supply of raw sugar for refining in Central Factories.

The following sub-committee was nominated :—

The President, Dr. Leather, Messrs. Howard, Smith, Moreland, Milligan, Knight, Couchman, Fremantle, Dr. Lehmann, Khan Bahadur Mohamed Hadi and Mr. Patel.

There was on view a large collection, made from all parts of India, of the different varieties of sugarcane, raw and refined sugars, samples of soils on which sugarcane is grown and the like. A most interesting demonstration was also given by Khan Bahadur S. M. Hadi of the improved indigenous processes of sugar manufacture followed in the United Provinces.

THE UNIFICATION OF METHODS EMPLOYED IN THE LABORATORIES OF AGRICULTURAL CHEMISTS.

The Board decided to form a sub-committee to deal with this subject the following being the terms of reference :—

(1) whether it is desirable to prescribe official methods of analysis to be followed in the Chemical Laboratories of Agricultural Departments ;

(2) if so, what methods should be prescribed ;

(3) whether it is desirable to suggest methods of analysis for other substances as a guide for Agricultural Chemists ;

(4) whether it is desirable to introduce a system of testing official methods by uniform samples analysed at each laboratory.

(5) to make any further recommendations on this subject.

The following sub-committee was nominated :—

Dr. Leather, Messrs. Bergtheil, Clarke, Barnes, Meggitt, Harrison, Plymen, Warth, Finlow, Dr. Mann and Dr. Lehmann.

SECOND DAY.

PROGRAMME OF THE IMPERIAL DEPARTMENT OF AGRICULTURE.

The programme of the Imperial Department was then considered. (Appendix C, page 25.)

The President remarked that certain of the programmes now submitted both of the Imperial and of Provincial Departments of Agriculture seem hardly to give sufficient information about the lines of work which it is proposed to follow, in order to enable the Board fully to exercise its advisory function. He suggested that, at least where it is proposed to

commence new work, a short statement should be given setting forth the lines on which it will be conducted.

8. In reply to the President, Mr. Howard gave a short account of the work which he proposed to undertake in the collection and investigation of fibre plants, mentioned in paragraph 2 of his programme. The first step will be to collect material for growing under uniform conditions, in order to determine whether the varieties of any particular fibre plant are true to type, and to isolate and examine the types. Then trials will be made to determine how far it is advisable to grow pure types or whether the mixtures so often found in the cultivated plant are advantageous in any way, or are unavoidable. *Hibiscus cannabinus* has been selected for immediate investigation.

9. Dr. Mann considered that the programme of the Imperial Department of Agriculture indicated a want of co-operation between the separate departments, and was lacking in inspiration. Certain of the experiments also appear to be typically local in character and should be relegated to provincial departments. He instanced the cultivation of sugarcane varieties mentioned in the programme of the Imperial Agriculturist. This is a local experiment; and in his opinion the work of Pusa should be of broader application. As an indication of the lines of sugarcane work which he thought Pusa might profitably undertake, he mentioned the following investigations: (1) the factors determining the proportion of sucrose and glucose in cane, (2) the factors determining the hardness of canes, (3) the factors determining the resistance of cane to disease, (4) the means of determining the time of ripeness of cane, other than by analysis, which is a method not generally applicable. In the discussion which followed, and in which Dr. Leather, Mr. Howard and Dr. Butler took part, it was pointed out that the varieties of sugarcane at Pusa are being maintained at Mr. Mollison's request and that until his return it is premature to speak of their rejection; that all the points mentioned by Dr. Mann for investigation are being or have been under study at Pusa or have been already the subject of research elsewhere, so that we have a considerable mass of information available. A high glucose content is known, for instance, to depend, amongst other conditions, on the immaturity of the cane, on its having lodged, on high manuring, on disease and on several other known conditions. Dr. Leather and Mr. Howard denied that there is any lack of co-operation at Pusa, and gave several instances of pieces of work carried out in co-operation.

PROGRAMMES OF PROVINCIAL DEPARTMENTS OF AGRICULTURE.

Programme of the Bombay Department of Agriculture.

[Appendix D, page 31.]

10. Mr. Fletcher stated, in reply to the President, that the experiments on land reclamation mentioned in paragraph 14 of his programme are being attempted under the following conditions:—

1. The reclamation of uncultivated coast lands flooded at high tides, and in which the problem is the removal of common salt. Previous work in this direction, which has been largely unsuccessful although considerable sums have been sunk, have been almost entirely carried out by embankments without drainage. It is proposed to introduce drainage on small plots taken up for the purpose.
2. The removal of alkali salts, of which the chief are sodium carbonate and sodium sulphate, in uncultivated arid tracts in Sind where irrigation is available. Drainage in open drains and the application of lime and gypsum to the soil will be tested at a farm available for the purpose.
3. The removal of alkali salts in areas with a small rainfall between twenty and thirty inches. An attempt will be made to wash out the salts without, if possible, any other assistance than that afforded by the rainfall. A farm is available on which this work can be carried out.

11. In reply to Dr. Leather, Mr. Fletcher explained that the survey of the cottons of the world, mentioned in paragraph 8 of his programme, is a broad

survey by countries in order to obtain the field characters of the types of cotton now cultivated in the cotton-growing countries. The aims of this survey are quite distinct from those of the survey of the Presidency cottons mentioned in paragraph 7, which is a detailed survey, taluka by taluka, or even village by village, so that accurate information may be obtained, not only regarding the main types, but also their varieties for every part of the Presidency, for purposes of seed distribution.

The recent severe outbreaks of boll-worm in cotton in Sind and in the Punjab were referred to. Mr. Fletcher and Mr. Main gave the results of their observations on the subject in Sind; Mr. Fletcher considered that the severe outbreak in the current season in Sind was due to favourable climatic conditions for boll-worm induced by floods, together with faulty methods of cultivation. Mr. Main stated that this year Egyptian cotton has been more severely attacked than the indigenous variety, and Mr. Fletcher added that this was probably due to the more branching habit of the Egyptian plant which had the effect of keeping the air moist between the plants Mr. Renouf summarised the history of the outbreak in the Punjab, and the measures taken to check it. In the Punjab a distinct improvement was noticeable this year, which there is fair evidence to show was, at least in part, due to the measures taken, the most useful of which were the burning of the stalks and refuse of the cotton plants in the fields after the completion of the picking season, and the introduction of parasites.

It is recommended by the Board that the Bombay Department of Agriculture should undertake measures for the checking of the boll-worm pest in Sind, similar to those carried out recently in the Punjab. The Imperial Entomologist will depute an assistant to investigate the special conditions prevailing in Sind, and detailed suggestions for future action can then be drawn up.

Mr. MacKenna considered that the discussion has brought out the importance of expert assistance in checking the pests of cultivated plants. In the Punjab the loss from boll-worm alone in 1905-06 is estimated at £2,000,000 and even if a portion of the recovery was due to the action taken (which seems certain), the expenditure was overwhelmingly justified; in Sind the difficulty is largely a question of establishment. The Board records its sense of the importance of the facts brought before it with reference to the losses resulting in the Punjab and Sind from the prevalence of the cotton boll-worm and desires to point out the necessity of strengthening the Entomological staff both in the Imperial and in Provincial Departments of Agriculture.

Arising out of the proposal of the Bombay Department of Agriculture to conduct the manurial experiments at Manjri station with quantities of manure expressed by bulk and not, as hitherto, by chemical composition only, a prolonged discussion took place regarding the best method of measuring fertilizers employed in manurial experiments. It was held, on the one hand, by Mr. Howard and some other members, that in India, the dominant factor being the water-holding capacity of the soil, the effects of bulky manures in modifying the texture and improving the mechanical condition of the soil may outweigh considerations based on the supply of plant food only. On the other hand, Dr. Lehmann, Dr. Leather and other members held that in manurial experiments as such, the quantities used can only be tested, for purposes of comparison, in terms of the chemical composition. The aim of manurial experiments proper being to determine the effects of known quantities of plant food supplied in different forms, the introduction of a second variable factor, such as the mechanical effects of special manures, must lead to confusion and should be the object of separate experiment. The Board decided to refrain from making any definite recommendation for the adoption of a fixed standard of chemical composition for the measurement of quantities of manure employed in manurial experiments, the aims and conditions of such experiments in different localities being too diverse to permit of any general rule being laid down.

Programme of the United Provinces Department of Agriculture.

[Appendix D, page 30.]

At the request of several members, Mr. Moreland outlined the progress which has been made, during the past two years, in the system in force in the

United Provinces of distributing seed of certain crops, on credit The main object at present is to broaden the basis of responsibility amongst cultivators receiving seed. Instead of distributing to individuals, groups of ten or fifteen men take up the seed and are jointly responsible for its return with interest. Owing to the advantages of this course, it has become possible to grant rebates of interest for punctual repayment at harvest time. The next step which it is proposed to attempt, at a favourable opportunity, is to develop these groups into co-operative societies so as to free the Department from much of its responsibility. In response to a general request, Mr. Moreland undertook to publish an account of the seed distribution work which has been carried out in the United Provinces.

17. The President suggested that it would be useful to obtain some definition of the responsibilities and functions of Agricultural Departments in this matter of seed supply. He did not consider that it is in any way the function of a Department to compete with private sources of seed supply. In the United Provinces the Department had a definite object in view—the introduction of a better variety of wheat into a tract where it was not previously known. Similarly in the seed distribution work in the Punjab, the Department had to deal with newly opened up country and new cultivators, in canal colonies, and the provision of seed became necessary.

The Board is of opinion that in regard to the supply of seed, the Agricultural Departments should not attempt to enter into permanent competition with existing sources, but should confine their efforts to showing the people how they can obtain seed from fresh sources, if necessary. The work of seed distribution should be limited to special cases, such as introducing new varieties by cultivating such on demonstration areas, providing seed of improved varieties of existing crops, or disease-free seed of certain crops.

Programme of the Bengal Department of Agriculture.

[Appendix D, page 35]

18. Mr Smith gave a brief account of experiments in transplanting paddy at Burdwan. Transplanting single seedlings has given the best results. A discussion followed in which Mr. Sampson, Dr. Lehmann and other members took part, the general opinion being that the most advantageous system varied with local conditions, such as water-supply, soil and climate.

19. Mr. Smith stated in reply to enquiries that the extension of cotton cultivation in Bengal is now practically confined, so far as the Department is concerned, to the Chota Nagpur Division. The results elsewhere have not been encouraging. Tree cottons as a whole have proved disappointing. The experience with this class of cottons in Behar and elsewhere has not given any promise of ultimate success in their cultivation.

Programme of the Madras Department of Agriculture.

[Appendix D, page 36.]

20. The Board recommends that efforts to stamp out the disease of Palmyra and Cocoanut palms prevalent in the Godaveri delta should form a prominent feature of the work of the Madras Department of Agriculture in the coming year.

Programme of the Punjab Department of Agriculture.

[Appendix D, page 37.]

21. A discussion took place on the prevalence of alkali lands in the canal colonies of the Punjab. Mr. Milligan gave evidence to show that in certain districts the evil is increasing and that a grave danger threatens the colonies, if efforts to check it are not taken at an early period. The President and Mr. Benouf pointed out that it has been stated that the total extent of *reh* land in the colonies has, if anything, decreased, but Mr. Milligan said that in certain places it is undoubtedly increasing as a sequence to irrigation and that the matter is in urgent need of investigation.

The Board desires to emphasise the importance of an enquiry into the occurrence of alkali lands in the Punjab irrigation colonies, and recommends

that the enquiry should be prosecuted in co-operation with the Irrigation and Colonisation Departments.

Programme of the Burma Department of Agriculture.

[Appendix D, page 37.]

22. Mr. MacKenna gave a more detailed account of some of the main lines of work outlined in the programme of his Department.

The Board is of opinion that, as the Imperial Entomologist is not in a position to give adequate assistance to Burma, owing to the very different conditions and pests in that Province, a separate Entomologist should be added to the staff of the Burma Department of Agriculture.

Programme of the Central Provinces and Berar Department of Agriculture.

[Appendix D, page 38.]

23. Mr. Clouston gave an account of the manurial experiments with artificial fertilizers on cotton which are being carried out in the Central Provinces. The first year's results point to nitrate of soda as being most successful.

24. The President described an enquiry which was made in Berar into the methods of seed supply of *Jari* cotton. It was found that practically the whole of the cultivators select their own seed from the crops after picking, and in doing so usually select the coarsest of the four types found in this cotton—the *Roseum* type. It is doubtful whether this is done deliberately to obtain a coarse, hardy and prolific variety, or is done because the *Roseum* bolls are usually larger and of better appearance than the others. The result, in all probability, accounts for the complaints received from the trade of the deterioration of staple in the past seven years, the counts of thread which can be spun from Berar *Jari* cotton having fallen from 10' or even 20' to 10', whilst the percentage of lint to seed has in the same period risen from 33 to 40 per cent. The enquiry is being prosecuted.

Programme of the Eastern Bengal and Assam Department of Agriculture.

[Appendix D, page 41.]

25. Dr. Mann enquired if the Department had taken any steps to supply jute seed to districts such as North Lakhimpur where there is a demand for seed. Mr. Finlow and Rai Bahadur Basu described the position of the seed supply at the present period, and stated that no difficulty was experienced in obtaining plenty of good seed in the open market; if a further demand arises, the Department is ready to provide any seed necessary to meet it.

The Board recommends that arrangements should be made for the supply of jute seed to cultivators in districts where it is a new crop and locally unobtainable and where there is a demand for it.

Programme of the Mysore Department of Agricultue.

[Appendix D, page 45.]

26. The Board has no remarks to offer on this progamme.

Programme of the Baroda Department of Agriculture.

[Appendix D, page 46.]

27. Mr. Patel explained that the difficulty in cheese-making consisted in the ripening of the cheese, which it was hoped to overcome by storing in cellars at a fairly even temperature. He invited suggestions for the utilization of skim milk, an important by-product of the large dairy industry of Guzerat, and some members promised to help him with such suggestions.

THIRD DAY.

COMMERCIAL FERTILIZERS IN INDIA.

28. The President gave a short statement of the circumstances which led to the raising of this question, the early papers in connection with which are published in Appendix D of the Board's Proceedings for 1906. Further information has been collected during the past year and notes regarding the employment of fertilizers in Mysore and in Eastern Bengal and Assam, have been submitted by Dr. Lehmann and Dr. Mann respectively. These will be found in Appendix E, page 47, to the Proceedings. In the United Provinces and Central Provinces, enquiry has shown that absolutely no trade exists in artificial fertilizers.

Mr. Couchman stated that whatever demand exists in Southern India comes entirely from planters The total area under planters' cultivation does not, however, exceed about 250,000 acres and only a few of the six or seven hundred planters of Southern India can afford to use fertilizers. Even amongst these the trade is contracting. The interests involved are, therefore, so small that legislation appears to be uncalled for. Nor is there any immediate prospect of the use of fertilizers spreading to the ryots. It has been said that the growing interest in the work of local agricultural societies and the increasing activity of Government in agricultural matters might be expected to result in the spread of artificials, but there is little real interest taken in these societies by the actual cultivators and as regards the Department of Agriculture other and more pressing lines of work must fully occupy its energies in the immediate future.

Dr. Mann stated that there is no demand for legislation in the tea planting districts, since fully guaranteed manures are available in sufficient quantity. Milled oil cakes are used by cultivators in the vicinity of Calcutta but there is little demand for any other class of fertilizer. In Bengal Mr. Smith considered that little hope appears to exist for any demand arising, since attempts by the Bengal Department to introduce bone meal and saltpetre have been quite unsuccessful.

Dr. Leather stated that there is a real awakening in recent years as to the value of oil cakes amongst the cultivators of India. Year by year prices have gone up in certain localities until they have reached a point at which they actually exceed the cost, per unit of nitrogen, of manures such as Chili saltpetre. Recent processes of obtaining nitrates from atmospheric nitrogen open up great possibilities, and we should be prepared for future developments. He considered that there is at least reason to watch this development carefully and to be prepared to legislate when occasion arises. In all other countries such legislation has become necessary.

Dr Lehmann did not agree with Mr. Couchman's conclusions regarding the use of fertilizers by planters in Southern India. There is a considerable and increasing demand amongst coffee planters in Mysore, and in Coorg the trade in fertilizers was stated by the Coorg Planters' Association to be one of the reasons for the provision of railway facilities to that district. He has also received applications from ryots for advice in the use of fertilizers and is convinced that a demand is springing up which will almost inevitably lead to the necessity of legislative control to prevent adulteration. The machinery required for this is simple and its effects will be to guard against a check being given to an agricultural practice which is singularly necessary in India where the soil is generally so deficient in plant food.

29. The Board is of opinion that on the evidence submitted to it the time is not ripe for the introduction of legislation on commercial fertilizers, but recognises the desirability of maintaining a special watch over the developments which may occur in their use.

30 The Board also recommends (votes 15 to 8) that the Provincial Departments of Agriculture should be prepared to undertake analyses of artificial fertilizers for private individuals, at a nominal fee, and to advise on the rate charged for them. Such analyses should not be carried out for commercial firms or dealers

The resulting risk of Agricultural Chemists being called as witnesses in civil suits to the prejudice of their work was recognised, but is at present small and these analysis can be stopped, if necessary, later on.

THE UTILIZATION OF RIVER SILT IN INDIA.

Sir Edward Buck presented before the Board a report on the control and utilization of rivers and drainage for the fertilization of land and mitigation of malaria. He gave an account of his investigations in Italy and India and suggested for the consideration of the Board the broad principles underlying the profitable utilization of fertilizing silt. (See Appendix F, page 71.) 31

The President welcomed Sir E. Buck in the name of the Board and expressed its thanks for the valuable explanation which he had given of his investigations in Italy and India. The enquiry has been taken up by the Government of India, and definite conclusions will doubtless be reached in due course.

Dr. Leather described the analyses which he has made in connection with this enquiry. (See Appendix F., page 73), and pointed out that the chemical characters of the silt do not show it to be a rich manure. It does not, in fact, differ materially from ordinary cultivated land, and in the case of hill streams may be considerably poorer. The quantity also is small. In most cases, from the ten streams analysed, the quantity was such that seven or eight feet of water would be required to obtain one inch of silt deposit. He did not wish to imply that silt is valueless as a fertilizer, but that its advantages must be sought in some other direction than chemical composition, possibly in its effects on the texture of the soil. With regard to the value of the dust washed down in the first monsoon rainfall, the quantity is so small that there is no possibility of its having any appreciable effect.

Mr. Howard was strongly of opinion that the fertilizing effect of silt is due to its mechanical action on the soil. In large deltas such as those of the Indus and Ganges, the silt deposited all along the delta is of one and the same origin; in the upper deltaic areas, however, only the coarser particles are deposited and coarse sandy soils result; in the lower portion alluvial clay of fine particles is formed. This may in itself explain the increase of fertility along the course of such rivers as they approach the sea.

A large amount of evidence was given by different members of the Board in corroboration of Sir Edward Buck's remarks on the agricultural value of silt. The President described the measures in vogue in the Central Provinces in embanking rice and wheat lands. These embankments are sometimes for the definite purpose of catching surface wash and building up the soil of depressions; in other cases they appear to be primarily intended to hold water only.

Mr. Moreland stated that any form of silt deposited in the sub-Himalayan areas would probably prove beneficial. In Bundelkhand where the embanking of fields is not a usual practice, it has been found the best of the famine protective works introduced. It is intended to catch surface drainage only, and the lines of embankments have to be laid out with considerable engineering skill. Mr. Hayman pointed out that in some cases harm may result from embanking, as for instance in increasing *Kans* grass in Bundelkhand, and that the work must be done with great care.

Mr. Fletcher described the systems of irrigation in Egypt. Two are largely employed. In the one case—the basin system—the flood water is caught in enormous basins up to twenty thousand acres in area and after settling for a month or two is again run off. In the other, canals are used, and the bulk of the silt is deposited in these and does not reach the fields. The agricultural advantages of the two systems differ greatly, for whereas in the former case there is a general rise in value of the lands so treated, in the latter there is often a depreciation. In this case part of the benefit of the silt is sometimes recovered by cleaning out the canals and putting the deposit on the fields. In some parts this is the chief manure employed and its value is well known, though from the point of view of chemical composition it is similar to the land to which it is applied. The effect is probably a mechanical rather than a purely chemical one. In Sind very much the same classes of silt deposit occur as in Egypt. There are catchment basins on a small scale into which the water is run from inundation canals and allowed to settle, and there are perennial canals which deposit silt in their own beds. In the former case the value is fully recognised. In the latter, of which the Jamrao system is an example,

the water is often not only useless for fertilizing purposes but complaints are sometimes made of its injurious effects. The crops on the Jamrao system are generally poor.

Mr. Wood described the application of tank silts in parts of the Madras Presidency where their value as fertilisers is well known. In river silts, good and bad qualities are known, the same river sometimes giving one or the other according as the rain to which its flooding is due arises in one or another formation of soil Mr. Fremantle also mentioned the value of tank silts in villages which is fully realised by the cultivators.

Dr. Mann stated that the largest yield of tea per acre in the Assam valley is obtained on an estate which habitually employes only river silt from the Brahmaputra for fertilising purposes. He said that he has now come to believe that silt alone may be sufficient in many cases to account for the continued fertility of inundated paddy lands, a fact which at one time was a source of great wonder to him. While the chemical composition of the silt fails to explain this, its mechanical effects may do so. Mr. Sampson agreed with this view, as he has seen extremely good results in Tinnevelly from carting silt on to paddy lands. As the silt appeared to be largely sand, the effect must be a mechanical one. A general opinion was expressed of the advantages of drainage maps of the nature described by Sir Edward Buck.

Sir Edward Buck was glad to hear such a considerable body of evidence in India in support of the views which he had put forward. The extension of the employment of silt in agricultural practice in India can only be done by strong Government assistance, as the areas available for private enterprise are individually too small and the private capital insufficient. It seems clear that there is a strong need for each province to obtain sufficient information to enable it to take up the matter on a definite plan.

32 The Board agrees that it is a grave error not to utilize fertilizing silt, wherever it may be profitably used.

That it is advisable to continue the analyses of the silt contained in our rivers and streams and of surface drainage, and wherever there is promise of success to carry out more detailed analyses, particularly as regards the first falls of rain. These analyses should include the mechanical characters of the silt.

That the co-operation of the Irrigation and the Agricultural Departments should be fully secured for these purposes.

THE IMPROVEMENT AND EXTENSION OF COTTON CULTIVATION IN INDIA

33 The President said that the Government of India desired to receive the advice of the Board regarding the best plan for assisting cultivators in disposing of small quantities of any new fine stapled cotton tried on a small scale. (See Appendix G, page 77.)

Mr. Mead described the system which has been adopted in Sind in dealing with Egyptian cotton This system has been fully detailed in a report to the Bombay Government. Arrangements were made by some zamindars direct with private firms, but the bulk was put on the market through Government agencies in public auctions. These were attended by the mill owners of Ahmedabad, and the greater part of the crop was taken, the first two auctions realising a high price. No considerable difficulties were experienced in carrying this out.

Mr. Fletcher held that whether in introducing exotics or in providing an improved type of local cotton, arrangements must be made to get full prices. Where the area is small, as in the first stages of introduction, Government must deal direct with the cultivators. Later on it is preferable to get private firms to take it up. In the beginning it is necessary to recover the seed for purposes of distribution and this can only be done by buying back direct from the cultivators. Once the advantages are realised, distribution will occur of itself and the recovery of seed be no longer necessary.

Mr. Renouf stated that the Dharwar-American cotton introduced in the Punjab was all sold in the first year to a local firm. Difficulties were

experienced in adjusting the accounts. The second year local mills bought the cotton at a premium of Rs. 1-8-0 per maund above indigenous cotton. This year about fifteen hundred acres were grown. To deal with this, a sum of £500 was asked for from the grant made by the British Cotton Growing Association, to be utilised in getting a broker to act as agent. No broker could, however, be got to take it up. A local firm was then approached and it agreed to take the crop at Rs. 1-6-0 premium, Government guaranteeing the brokers' expenses. At the same time a local broker in Lyallpur, after independent enquiries, came forward and took up a proportion of the crop at from Rs. 1-8-0 to Rs. 1-13-0 premium, and the success of this enterprise will lead to its continuance in the future. The intervention of Government is not as a rule advisable, for their agency is not always favourably regarded by the cultivators, and they are not in a position to know the true value of the crop.

Mr. Hayman stated that the acclimatised American cotton introduced in the United Provinces has not extended sufficiently for private intervention. All is bought by the Department. He doubted if a demand will arise for this cotton, unless it is found to mix with southern cotton, a point now being tested by the mills.

The Board is of opinion that the purchase by Government of the produce of newly introduced cotton should be restricted to the earlier stages when the area to be dealt with is small. When the area commences to expand, the assistance of private firms may usefully be sought, the firms acting either as agents for Government or as principals under a guarantee against loss. When the area is somewhat larger the system of Government auctions introduced in dealing with the Egyptian cotton in Sind is a suitable one. The concentration of trials in a compact tract rather than their distribution over a wide area would greatly facilitate the disposal of the produce. 34

FOURTH DAY.

THE IMPROVEMENT OF THE INDIAN SUGARCANE INDUSTRY.

The report of the sub-committee appointed to draft a memorandum on this subject was considered. 35

A discussion took place on the question of specifying certain localities in which the conduct of sugarcane experiments is advisable. The Agricultural Department of Eastern Bengal and Assam invited the opinion of the Board on the suitability of the Jorhat Experimental Station for this purpose, but the Board does not consider itself in a position to specify the localities in which sugar stations should be established.

On the question of the conduct of field experiments in sugarcane, Dr. Mann advocated the constant supervision of a competent observer in order to obtain a more accurate determination of the characters of the crop than can be gained by weighment only in the hands of assistants untrained in methods of precision. He referred to the conclusions arrived at by Mr. Barber at the Samalkota Station which bear out his contention. Dr. Lehmann did not believe that observation can ever compare with the balance in testing the yield of a crop. Whilst admitting the necessity for such observations, the results should be judged chiefly by the balance. The assistants in charge of sugar stations should be sufficiently reliable to be able to carry out weighing tests in a trustworthy manner. Mr. Couchman pointed out that, though the results obtained at Samalkota had been largely arrived at by the methods suggested by Dr. Mann, frequent analyses and weighments had been made and the figures preserved on record at the station.

In planning plots for sugarcane experiments, Mr. Sampson and Mr. Fletcher drew attention to the danger of allowing seepage from one plot to another to interfere with the results. This danger may be avoided by surrounding each plot with two or three lines of sugarcane which are not included in the consideration of the results, as is done at the Manjri station in Bombay.

Dr. Mann believed that it is unnecessary for several stations to conduct experiments to determine the requirements of cane in plant food. This can be

done once for all. What each station should aim at determining by its manurial experiments is the best manure to provide for a particular set of conditions of soil and climate.

Dr. Mann and Mr. Howard considered that it is of importance to experiment, with the object of ascertaining whether any accurate means of determining the time of ripeness of cane, other than by analysis, can be discovered. No other method than this is apparently known, and several members remarked that cane growers in India are often obliged to carry out experimental boilings to find the proper period for cutting. Dr. Mann also suggested that experiments should be conducted to aim at the provision of some form of raw sugar other than *gur* for supplying refineries. The great losses in handling *gur* and the limited period of the year during which it can be worked are obvious disadvantages.

Mr. Moreland suggested that Government should be prepared to consider the desirability of granting assistance to pioneer central factories when suitable localities for such factories have been found. The difficulties which pioneers in an industry such as this have to contend with are often considerable, and may in some cases be lightened by fuel concessions, assistance in acquiring land or other similar means Dr. Leather agreed with Mr. Moreland that the early stages of central factories are beset with difficulties, the chief of which is a want of confidence between the factory and the cultivator. The former cannot rely on getting his full promised supply of cane; the cultivator is unwilling to abandon his own methods for a procedure which he has no certitude will continue or repay him in the long run.

36 The Board suggests that Local Governments may consider the advisability of granting concessions to pioneer central factories when suitable tracts for the establishment of such factories shall have been found.

37 The Board adopts the report of the sub-committee on the improvement of the sugarcane industry as modified below :—

Scheme for the improvement of the sugarcane industry of India.
Sugarcane experiments on the scale contemplated by the terms of reference should only be started in tracts where the crop is at present of *commercial* importance or likely to become so. In tracts where sugarcane is grown only for domestic consumption, the trials (if any) should be on a much more limited scale.

2. The information given in the provincial reports as to the increase or decrease of sugarcane cultivation in each province is not complete, but it does not tend to show that there has been any important change except in a few isolated cases. The fluctuations in area, which sometimes extend over short periods of years, appear to be due mostly to seasonal variations in the rainfall, particularly at the planting season, and to the economic condition of the people. Thus the decrease in recent years in the Bombay Presidency appears to be due to bad seasons, and the reduction in the resources of the cultivators owing to the effects of famines. In the United Provinces (which account for practically half of the total area under cane in India) the cultivation has been fairly constant, and as the result of a favourable planting season this year's area is very nearly the highest on record. The Bengal statistics show a large reduction from 755,000 acres in 1890 to 433,500 acres in the present year, but these statistics have to be received with caution, while in recent years the reduced prices of sugar and the profits on jute cultivation are believed to have resulted in a contraction of the cane area. The large reduction in the Central Provinces from 96,000 acres in the early sixties to 18,000 acres last year is believed to be principally due to the extension of railways; in early years the cultivators were obliged to grow home supplies, but they have been unable to compete with the more favourable cane tracts of the United Provinces and Bombay, and have substituted other more profitable crops, such as cotton. Before undertaking any important scheme of sugarcane experiments in a tract, it is recommended that the past history of sugarcane cultivation should be thoroughly inquired into.

3. *The objects of a sugarcane experiment station* are some or all of the following :—

(*a*) Cultivation Experiments (including preparation of the land, methods and times of planting, supply of canes for sowing, distance apart of the canes, methods of after cultivation, mulching, trashing, irrigation, drainage, and the like).

(*b*) The investigation of the manurial requirements of the cane, and the available supplies of manures.

(*c*) The testing of varieties with a view of introducing a better cane.

(*d*) The improvement of existing canes by chemical selection.

(*e*) Attempts to raise seedling canes.

(*f*) The methods for preventing the ravages of pests and diseases.

(*g*) Improvements in the manufacture of the product.

(A) *Cultivation.*

4. In conducting the field experiments, the plots should be if possible one-fifth of an acre or at the very least one-tenth of an acre in area. They should be oblong in shape and laid out as long as practicable, at least 2×1. Oblong plots ensure greater uniformity in soil conditions and greater ease in cultivation. Land should be chosen as uniform as possible, and if necessary the soil of each experimental area should, in the first place, be carefully tested by growing crops until sufficient uniformity is secured. In cases where danger of seepage exists, a sufficient margin should be left round each plot to counteract this factor, such margins being also cropped. The number of sets in each plot of a series should be the same and should be examined for freedom from disease, and great care should be taken to check pests at the outset. Great care should also be taken to replace vacancies. The irrigation water for each plot should be carefully measured.

5. To enable the experiments to be made year after year provision must be made for rotation. This requires that the total area available for experiments should be at least twice that under cane in any given year. To ensure accuracy it is desirable to duplicate all the plots.

6. *The area required.*—At sugar stations throughout India care should be taken not to undertake experiments at several stations which can be equally well done at one. An area of about 12 acres under cane is a suitable standard of area for a sugar station, sufficient allowance being made in addition for rotations.

7. *Equipment.*—In providing equipment at sugar stations, efficient work should be aimed at, irrespective of cost, and the question of working stations at a profit should not be taken into consideration. The equipment is a matter of importance at all sugar experiment stations including the Poona (Manjri) Farm. As it is essential that there should be no delay in crushing the experimental canes as soon as they are ripe, a power mill is necessary, capable of dealing with about 2½ to 3 tons of canes per hour or 30 tons per working day. The mill should be sufficiently large to crush each plot as soon as it is ripe. The estimated cost of this equipment is about Rs. 7,500 (including shed).

8. *Ripening of the cane.*—In conducting field experiments with sugarcane, it is essential to determine when the cane is ripe and at its best. The only safe method is to analyse the cane as it approaches ripeness once a week or once a fortnight. The appearance of the cane is not a sufficient index to determine whether it is ripe. The analyses can be conducted by a reliable trained Indian assistant When the plots are large, trial boilings can also be conducted in conjunction with the analytical work. Investigations of other methods of testing the ripenness of cane should, if possible, be undertaken.

9. *The determination of the yield.*—As neither the weight of canes nor the amount of *gur* is a reliable index of the yield, it is necessary to weigh the canes, to crush them, and to determine the amount of sucrose in the juice and that left in the bagasse. The results of an experiment should be expressed in

tons of sucrose in the cane per acre, and the purity of the juice should also be recorded. A calculation of the results from the weight of the canes and the analysis of a sample is not desirable. The determination recommended is the most reliable test, but, if desired, the juice can be made into *gur* and the weight stated, for the information of cultivators.

(*B*) *Manufacture.*

10. *The manufacture of gur or jaggery.*—A careful inquiry should be made into the actual efficiency and the losses that occur at the various stages of the indigenous processes for the manufacture of *gur* or *jaggery*, with a view to ascertain the best methods of lessening such losses.

11. *Milling.*—The following information concerning milling tests was supplied. In the United Provinces with thin canes, the best of the iron mills in ordinary use gives about 65 per cent. of extraction, whilst the inferior mills give about 45 per cent. In Mysore, with thick canes, the local 3-roller iron vertical mill gives 67½ per cent. of extraction, whilst a small power mill gives 76 per cent.; these mills were working at their highest efficiency. In Bombay, the local Poona mill with thick canes gives an extraction of 68 to 72 per cent. The improvement of the local mills is, therefore, one of the most important branches in which advance seems possible.

12. *Receptacles for collecting juice.*—Experiments in Mysore show that losses from fermentation due to the use of dirty receptacles amount to about 10 per cent. of the sugar in the juice. The discarding of earthenware pots, and the use of iron or copper receptacles, combined with cleanliness would prevent a considerable proportion of this loss.

13. *Liming.*—In the United Provinces liming is not practised, *sājji* (carbonate of soda) being used, which results in great losses of sugar. In Mysore experiments have shown that the average loss of sucrose from imperfect liming amounts to 18¼ per cent. A careful investigation should be made into the liming processes, in which attention should also be given to its effects on the colour and the keeping qualities of the *gur*.

14. *Methods of straining and skimming.*—Inquiry should be made into the possibility of improving the existing methods by the use of filter clothes and the like.

15. *Boiling.*—Inquiry should be made into the losses that occur through delay in boiling, charring, burning and the like. The possibility of introducing boiling pans of improved shape should be considered.

16. *Indigenous processes of sugar-making.*—A careful investigation of indigenous processes of sugar-making should be made with a view to improvement on the lines followed in the United Provinces. It also recommends an investigation of the Hadi processes to determine the actual losses that occur at each stage and the possibility of avoiding them. The Hadi equipment, consisting of three boiling plants, centrifugal and engine with boiler, costs about Rs. 4,650, exclusive of mill, which may either be worked by engine power or by bullock), which deals with 40 maunds of *rab* a day giving 20 maunds of sugar =1½ acres of cane a day or 100 acres of cane in a season.

17. *Small power factory system.*—The type of equipment depends on the class of sugar to be produced; the production of *white* sugar postulates the use of vacuum pans, which involve a substantial area of cane (100 acres or more) for their efficient use, whilst sugar of a lower grade needs only open pans and steam boiling. The type of equipment usually employed on small factories in the West Indies for the production of 'muscovado' sugar, consists of a 3-roller mill, clarifier, settling tank, filter press, sulphur apparatus, open train of evaporators, pug-mill, centrifugal, engine and boiler. It is roughly estimated that a plant of this description, dealing with 2 tons of cane per hour in a working day of 12 hours, or 1,500 tons of cane over a working season of 63 days (=about 50 acres of cane in the Poona district or 100 acres of cane in the United Provinces) would cost about Rs. 20,000 or including necessary buildings, etc., Rs. 25,000. This amounts to a heavy outlay per acre of cane, but from the information available, it would seem that the losses avoided by using such a plant, including an estimated saving of 9 per cent. of

juice in milling, 10 per cent. of sugar outturn from avoidance of inversion, and allowing for loss on the molasses and for the cost of working, would, apparently, give a fair prospect for its introduction into suitable tracts, provided that local conditions are favourable. The Board recommends that, if further inquiries verify this forecast, such a small power factory might be tried as an experiment at a suitable sugar experiment station.

18. *Central Factory System.*—The information before the Board was not sufficient to enable them to state the conditions necessary to the successful working of a large central factory, including the supply of cane or raw sugar required. It is recommended that these conditions should be ascertained, that Departments of Agriculture should make local inquiries as to the tracts where these conditions are most nearly approached and publish the results for general information. The causes of failures of this system in certain cases should be inquired into.

19. *Imports.*—The imports of all classes of sugar, which have increased from 168,000 tons in 1891-95 to 317,000 tons in 1905, amounting to 2¼ lbs. per head of the population of India, show the great demand for sugar in India. The attached letter from the Bombay Chamber of Commerce gives some interesting information as to the class of import trade at that port. (See Appendix II, page 83.)

20. It is desirable that a conspectus should be made of the results of previous experimental work on sugarcane in India, including a critical examination of the results.

VETERINARY MATTERS.

1.—The Curtailment of Grazing Grounds.

Colonel Morgan stated that this question was raised at the last meeting of the Board of Agriculture and its full consideration postponed for the collection of information from Local Governments. The papers received in connection with the enquiry are laid before the Board (Appendix I, page 231). From these it would appear that few definite suggestions have been offered, and the only point remaining for the Board to decide is whether a further and more detailed enquiry is called for. In the Punjab canal colonies and in Sind, it has been reported that the extension of cultivation is resulting in a serious contraction of the large breeding herds that supply the work cattle of many districts. 38

The President briefly recounted the enquiries which have been made in the past into this question, and the instructions issued by Government from time to time. Practically none of the recommendations which have been made have fully secured the objects aimed at. Grass and fodder reserves have only led to the increase of local cattle up to the limit of supply in good years and consequently great mortality when scarcity arose.

Mr. Sampson and Mr. MacKenna mentioned specific instances in Ongole and in Burma where this difficulty does not exist, but the conditions in the latter Province are not applicable to other parts of India.

The Board is of opinion that the evidence before it is not sufficient to justify any further enquiry on the subject of the improved provision of grazing grounds in the large cattle-breeding districts, as no further information appears to be available on the subject, and it would not be likely to lead to any practical result. 39

2. The Provision of Fodder in Times of Famine.

The President stated that this matter has also been before Government for years; he gave a summary of the past history and of the recommendations to be found in the Famine Commission Report of 1901. In Bombay the chief recommendations were (*a*) to stimulate the growth of fodder by the grant of loans and other assistance, (*b*) to import fodder from other parts, (*c*) to deport the cattle from distressed districts to forests or other available better areas, and (*d*) the provision of Government cattle camps. The first of these has been found by experience to do much good in suitable tracts, and the importation of fodder is preferable, generally speaking, to the deportation of the cattle. The Famine 40

Codes of the Provinces in general adopt these recommendations, which form the basis for action in time of famine.

The Indian Famine Union recommend in addition the introduction of drought-resisting plants, such as salt bushes, into famine liable tracts. In practically every case, however, in which this has been tried, it has proved a failure.

The storage of fodder, which has also been recommended has not been found practically successful as deterioration is rapid. This Board recommended in 1906 the botanical investigation of fodder grasses, and this is already in progress in some provinces.

Other members of the Board discussed the advantages of ensilage, the improvement of pasture grounds and the systems of grazing, which questions have been successfully taken up in some parts of India. The Board considers that Departments of Agriculture should, where possible, take up these lines of work.

3. THE BEST METHODS OF UTILIZING THE SERVICES OF VETERINARY ASSISTANTS, *i.e.*, BY STATIONARY WORK IN DISPENSARIES OR BY ITINERATING WORK IN VILLAGES.

41. The Board is of opinion that this is an administrative matter which can be more profitably dealt with by the contemplated Board of Veterinary Science.

FIFTH DAY.

AGRICULTURAL ENGINEERS.

42. Sir Edward Buck presented a note on the training of Agricultural Engineers, which is printed as Appendix J, page 240 of these Proceedings. He referred to the valuable work which was begun at Cawnpore by Messrs. Wilson and Clibborn at the time when he was Director of the Department. He wished the opinion of the Board on the following points :—

1. Whether it is desirable to have a corps of agricultural engineers attached to the Agricultural Departments in India.
2. Whether a survey of each province should not be undertaken to determine the directions in which agricultural engineers could be profitably employed.
3. How best the competent experts required for this work should be obtained

Mr. Moreland supported Sir Edward Buck's opinion of the value of the work carried out by the professional engineers who had been at one time attached to the Department. Their length of service was too short to permit of many problems being solved, but they laid the foundation of practically all that is known regarding the construction of spring wells in these Provinces. The Irrigation Department is not in a position to deal with the provision of wells, and small works of this sort must be in the hands of cultivators and landholders. It must be the duty of the Agricultural Department to ascertain where there is room for increasing the number of wells. It must also determine what difficulties in well construction exist in specific places, and it must endeavour to overcome these difficulties. Records of the localities requiring more permanent wells are now available for these Provinces. Similarly it is now known where temporary wells may be required in times of distress, and details of their cost, time required for construction, etc, have been obtained. This information will be referred to in the United Provinces Famine Code. The Board of Revenue now undertakes to provide any advances required where the survey has shown that wells are needed, and further than this, Collectors are instructed to let it be known that Government is anxious to encourage *the making of wells and ready to advance the capital required.* In some cases the cultivators themselves are not certain that wells can be made and if so how far they will prove useful. In these cases assistance will be given them by sending down a staff to determine whether wells can be

made and what precautions should be taken in their construction. The additional staff employed for this purpose is a trained man who makes and looks after the tools and three overseers who are in charge of the boring parties. Part of the staff has had to be obtained from Engineering Colleges, and the Agricultural Colleges would not be competent to provide such men.

The President said that during the famine of 1899-1900 in the Central Provinces temporary wells were constructed in the Chattisgarh rice districts. Many of these were successful but some were failures. This depended on the fact which was apparently brought out, that there is a flow of underground water along the slopes in this area which can successfully be reached by temporary wells for a short period after the cessation of the monsoon rainfall. The Agricultural Department was inadequate to carry out a survey of this underground water. Another question in which assistance is required in the Central Provinces is in the case of wells bored in the districts where rock is near the surface. A substantial proportion of these are failures. Trial borings are called for where it is proposed to make these, but no provision has yet been made for a boring staff, pending the publication of the results of the work in the United Provinces. The diversity of the work in which an engineer can assist Agricultural Departments is so great that there is ground to doubt whether a single man could be obtained capable of dealing adequately with all branches of it.

Mr. Mead said that the Bombay Department has begun to assist in well construction, and with success in alluvial soils though not to any extent in rocky localities. It is proposed to organise the staff required through the Public Works Department. In Guzerat local expert assistance is available to the Department and trial work is being carried on in this area. Work in checking erosion in parts of the Deccan is also being taken up on a small scale.

Mr. Renouf stated that measures are being prepared by the Punjab Department of Agriculture to carry out minor irrigation works on the lines recommended by the Irrigation Commission. A survey is being made of suitable localities and a scheme is under consideration in conjunction with the Chief Engineer of the Irrigation Department, somewhat on the lines of that of the United Provinces. As regards the staff he was of opinion that skilled engineering advice is essential in minor irrigation works, and would prefer trained Public Works Department subordinates to agriculturally trained men with a smattering of engineering for the subordinate staff.

Mr. Couchman referred to the useful work carried out by Mr. Chatterton in raising well water by power. Mr. Chatterton's staff inspects wells in which there is a prospect of increasing the water supply by providing engines, and advances are given in suitable cases to provide the plant, which is erected by the Department.

Dr. Leather referred to the assistance which can be given by engineers in agricultural machinery. He considered that a full engineering training is essential for agricultural engineers. Mr. Fremantle, while admitting the importance of the engineering aspect of work such as Mr. Chatterton's, considered that for the main subjects of minor irrigation works referred to in Sir Edward Buck's note, agricultural knowledge is all important and for the subordinate staff at least he considered that the main training should be agricultural, an engineering course, preferably at an engineering college, being added.

Dr. Lehmann said that as regards implements the best assistance can be obtained from a trained agricultural staff rather than from professional engineers.

Major Atkinson considered that the discussion has shown that a highly skilled engineer to advise on schemes of minor irrigation works, checking erosion and improving land by silting, seems to be required. He should also have a special knowledge of mechanical engineering to enable him to advise on implements, power systems of raising water and similar matters. The existing specialists in irrigation and hydraulics in the country probably are unable to devote sufficient time to more specially agricultural matters. The ordinary training of Public Works Department subordinates does not appear to be quite

suitable for the staff required to deal with questions such as those discussed. In addition to one skilled engineer attached to each Department, a small number of subordinates specially trained would be required, one to deal with machinery, one for well-boring and so on. This would still leave a certain number of smaller aspects of agricultural engineering in which the trained agriculturists could profitably advise. Mr. Fremantle's suggestion of a special course of engineering in engineering colleges for agricultural students required to deal with these questions is impracticable, unless much more time can be given than is likely to be available.

43 The Board is of opinion that skilled engineering assistance is desirable in Agricultural Departments of Provinces where this aspect of agricultural improvement is important, and that this matter should receive consideration by Local Departments. The training to be provided for the staff is also a matter for further consideration in view of local requirements.

THE UNIFICATION OF METHODS EMPLOYED IN THE LABORATORIES OF AGRICULTURAL CHEMISTS.

44 The following report of the Committee appointed to consider this question is adopted by the Board.

Report of the sub-committee for the unification of the methods of analyses in Chemical Laboratories of Agricultural Departments.

The points of reference which the sub-committee considered were as follows:—

(1) whether it is desirable to prescribe official methods of analysis to be followed in the Chemical Laboratories of Agricultural Departments;
(2) if so, what methods should be prescribed;
(3) whether it is desirable to suggest methods of analysis for other substances as a guide for Agricultural Chemists;
(4) whether it is desirable to introduce a system of testing official methods by uniform samples analysed at each laboratory;
(5) to make any further recommendations on this subject.

Item 1.—It was recommended that the principle be adopted of having official methods, the use of which will be binding on the Chemists of the Agricultural Departments.

Item 2.—Methods for the analysis of the following classes of substances were considered:—Soils, Feeding-stuffs, Manures, Waters, and it was decided to make the following methods official.

A. Soils. (*a*) *Sampling.*—That in all ordinary cases and unless special circumstances interfere, the surface soil shall be defined as the first 20 cms.

(*b*) *Definition of fine earth, and the sieve to be employed.*—Fine earth to be that portion of the soil which will pass a sieve with round holes 1 m.m. in diameter.

(*c*) *Chemical Analysis.*—Available phosphate and potash. Dyer's method.

B. Feeding stuffs.—*Woody fibre.*—The strength of the acid and alkali used to be 1¼ per cent. and the period of digestion to be ½hr. in each case.

C. Manures.—Methods for the extraction of soluble and insoluble phosphates.

D. Waters. (*a*) *Albuminoid Ammonia.*—Wanklyn's method.

(*b*) *Oxygen absorbed.*—Method of Clowes and Coleman.

Item 3.—The Committee consider that it is desirable to recommend methods for use in Agricultural Laboratories, and the details of such methods should be revised annually.

Item 4.—It is desirable to test official methods but the necessity for testing such methods must be considered separately in each case.

Item 5.—The full details of the methods should be published with such illustrations as may be necessary, and revised annually. For the present 100 copies will be a suitable number to print.

APPENDIX A.

PROGRAMME FOR THE THIRD MEETING OF THE BOARD OF AGRICULTURE.

SUBJECT I.—*The confirmation of the Proceedings of the last meeting.*

A note is attached (see Appendix B, page 21) showing the action taken on the recommendations of the Board.

SUBJECT II.—*The Programme of work of the Imperial Department of Agriculture.*

A consideration of the programmes of—

(1) The Director, Pusa Research Station;
(2) The Imperial Agricultural Chemist;
(3) The Imperial Economic Botanist;
(4) The Imperial Mycologist;
(5) The Imperial Entomologist;
(6) The Imperial Agriculturist.

2. Provincial Directors should examine them to see whether they meet the requirements of their own Provinces; Imperial experts should examine them to see whether the programmes of branches, other than their own, meet their requirements.

SUBJECT III.—*The Programmes of work of the Provincial Departments of Agriculture.*

A consideration of the programmes submitted by—

(*a*) Bombay.
(*b*) United Provinces.
(*c*) Bengal.
(*d*) Madras.
(*e*) Punjab.
(*f*) Burma.
(*g*) Central Provinces and Berar.
(*h*) Eastern Bengal and Assam.
(*i*) Mysore State.
(*j*) Baroda State.

2. The Imperial experts should consider whether the programmes meet their requirements, and whether they can suggest improvements. The Provincial Directors should consider whether the programmes of other Provinces can be improved so as to meet any special requirement of their Province or to ordinate the work.

SUBJECT IV.—*The Improvement of the Indian Sugarcane Industry.*

A consideration of the notes submitted by the Provincial Departments and a discussion as to the best lines for future experimental work.

SUBJECT V.—*Veterinary matters.*

A discussion of the notes submitted to the Board, dealing with the following matters:—

(*a*) The curtailment of grazing grounds;
(*b*) The provision of fodder in times of famine;
(*c*) The best methods of utilizing the services of Veterinary Assistants, *i.e.*, by stationary work in dispensaries or by itinerating work in villages.

SUBJECT VI.—*The unification of methods employed in the laboratories of Agricultural Chemists.*

A consideration of the note* submitted by the Imperial Agricultural Chemist on laboratory methods.

* Distributed to Chemists only.

SUBJECT VII.—*Commercial Fertilizers in India.*

A consideration of the notes submitted by certain members of the Board.

SUBJECT VIII.—*The utilization of river silt in India.*

Sir Edward Buck will present a note on the above subject and will explain to the Board the results of his recent enquiries in Italy.

SUBJECT IX.—*The improvement and Extension of cotton cultivation in India.*

The consideration of the methods which should be adopted for the utilization of the grant made by the British Cotton Growing Association for the improvement of Indian Cotton.

SUBJECT X.—*Agricultural Engineers.*

The consideration of a note presented by Sir Edward Buck. (See Appendix J, page 240.)

F. G. SLY,

Offg. Inspector General of Agriculture in India and President, Board of Agriculture in India.

APPENDIX B.

Note showing the action taken on the Proceedings of the second meeting of the Board of Agriculture in India.

This note has been prepared for the information of the members of the Board of Agriculture, to show the action taken on the recommendations made at the second meeting of the Board of Agriculture. The references are to the numbered paragraphs of the proceedings of that meeting, those in which no action was necessary being omitted.

Item 3.—Supply of European Stores.—The Inspector General of Agriculture again brought to the notice of the Government of India difficulties that at present exist regarding the supply of European Stores required for experimental purposes in the laboratories of the Departments of Agriculture, both Imperial and Provincial. At the instance of the Secretary of State, the Government of India have again asked the Inspector General of Agriculture to submit a report on the actual experience of the Imperial officers, which report has been submitted.

Item 4.—The Government of India (Department of Revenue and Agriculture) in their letter No. 188—12-16, dated the 26th January 1906, to the Inspector General of Agriculture, have laid down, for the guidance of the Imperial experts, the principles of inter-communication between Provincial experts of the Agricultural Departments and themselves.

Items 5 to 11 and 74.—Agricultural Education.—The Government of India have invited the attention of all Local Governments to the standard curriculum of studies in Agricultural Colleges recommended by the Board, and have asked the Local Governments to make use of it in drawing up the curriculum of the Agricultural Colleges in their respective provinces.

Items 12, 13 and 66.—Programme of Research Work of the Pusa Institute.—The general principles laid down by the Board as regards the research work of the Pusa Institute have been borne in mind in the framing of the programmes for the coming year.

Items 14 to 22.—Programmes of the Imperial Experts.—The remarks of the Board have been communicated to the officers concerned for their information.

Item 14.—The Government of India agree with the Board's recommendation that the publication of the results of analyses must be left to the officers concerned.

Item 15.—Dr. Leather has arranged at Pusa to carry out analyses of sugarcane during different stages of their growth so as to test the period of actual ripening. He and Mr. Shearer have also drawn up a note on the prospective sugarcane experiments which is appended for the information of the Board.

In February last the Imperial Agricultural Chemist deputed one of his assistants to the Central Provinces for analysing sugarcane juice in the field. The assistant visited Lanji in the Balaghat District in order to check the results of the previous year's analyses, but the seasonal conditions of the year were unfavourable to the experiments. Bad weather also intervened, and some of the canes intended for analyses were found to have been cut for 8 days The analyses nevertheless indicated it a very good cane, though not of the same quality as in the previous year.

Dr. Butler continued the work of selecting sugarcane grown at Pusa with a view to eliminating disease, and Dr. Leather tested the canes both with regard to the percentage of juice and the percentage of sugar.

Item 17.—The experimental work on indigo at Pusa has been abandoned because more important work occupies the attention of the Imperial Economic Botanist, and because it seems desirable to concentrate all the work at Sirsiah Research Station of the Indigo Planters' Association.

Item 18.—Experiments for resisting the pigeon pea wilt disease have shown a considerable promise in the Bombay Presidency. The selected seed from the disease infected plots at Kirkee Farm has this year given a crop with at least 75 per cent. less diseased plants than last year's crop. The work will be continued.

Similar experiments at Pusa were lost owing to the floods so that no infections were carried out.

Item 19.—The Pusa Institute has published a bulletin by Mr. Lefroy, on the cotton boll worm of the Punjab which describes the measures to be adopted against boll worm. The Imperial Entomologist visited the Punjab several times during the year and suggested means to check the ravages of the boll worm to the cotton crop of the year. The results of the introduction of parasites are encouraging and justify the continuance of the work on these lines.

Item 21.—The Imperial Entomologist visited United Provinces during November 1906.

Items 23 and 24.—Programmes of Provincial Departments.—The Government of India have invited the attention of the various Local Governments to the general principles recommended by the Board.

Item 25.—Bombay. Alkali Lands in Sind.—In July 1906, the Bombay Government submitted proposals to the Government of India for the appointment of a specialist for five years to investigate the alkali problem in Sind. Before submitting the proposals to the Secretary of State, the Government of India have asked the Bombay Government to furnish them with some facts as to the nature and magnitude of the alkali evil, the time from which it dates, the rapidity with which it is spreading and the factors to which it is apparently due. The question is still under consideration.

Item 26.—Experiments in the introduction of Egyptian cotton in Sind.—The Director of Agriculture, Bombay, has fully described the results of the experiments with Egyptian cotton in Sind obtained during the season 1906, in Appendix B to the Annual Report of the Department of Agriculture, Bombay Presidency, for the year 1905-06. It was decided to restrict the cultivation to such area as could be effectively supervised in order to introduce a knowledge of the Egyptian methods of cultivation. Fifty tons of seed were imported from Egypt and 5,000 acres are reported to be under this cotton during the season.

Item 27.—Investigation of the ground-nut tikka disease.—Is promising well and will be continued during the year. It has been suggested that the disease might be checked by introducing new and early ripening varieties. The Bombay Department of Agriculture has arranged to obtain from America, Japan and Pondicherry 5 tons of seed from each for distribution before May 1907.

Items 28 to 31.—United Provinces.—The Government of India have invited the attention of the Local Government to these items.

Item 32.—Bengal.—The Government of India have invited the attention of the Local Government to this item.

Items 33 and 34.—Madras.—The attention of the Local Government has been invited to these items. Mr. Finlow's bulletin on the extension of jute cultivation describes the proposals for extending this crop.

Item 35.—Punjab.—The Government of India have invited the attention of the Punjab Government to this item.

Items 37 and 38.—Central Provinces.—The Government of India have invited the attention of the Central Provinces Administration to these items.

Items 39, 40 and 41.—Eastern Bengal and Assam.—The Government of India have invited the attention of the Local Government to these items.

Items 43 to 50.—The Improvement of Indian Wheat.—The Government of India have again addressed the Secretary of State regarding the appointment of a Wheat Expert. They have also suggested to the Local Governments the desirability of completing, as far as possible, an agricultural survey of the varieties of wheats grown in their respective provinces.

Items 51 to 55.—The Improvement of Indian Tobacco.—The Government of India have again recommended to the Secretary of State the appointment of a Tobacco Expert without whom it is not possible to adopt the Board's suggestions on the subject.

Items 56 to 60.—Veterinary.—The matters included in these recommendations are still under the consideration of the Government of India. It is also under consideration whether a separate Board of Veterinary Science in India should be established.

Items 61 to 65.—Commercial Fertilizers.—The Government of India negatived the proposals of the Board of Agriculture for the appointment of a Committee to collect information concerning the use of Commercial fertilizers in India, for the purpose of considering the possibility of introducing a system of inspection and control by legislation or otherwise. This decision has been communicated to the members of the Board with the permission of the Government of India in order to enable those who are specially interested in the subject to collect further information for further consideration by the Board.

At its last annual meeting held on the 13th August 1906, the United Planters' Association of Southern India discussed at considerable length the subject of the need of Government control over the sale of artificial fertilizers. The meeting was attended by the Inspector-General of Agriculture, Drs. Leather and Lehmann. The Association has submitted a resolution urging earnestly a reconsideration of the recent decision of the Government of India in this matter and requesting that a searching inquiry may be instituted with a view to the early introduction of some system of control on the lines existing in the United States.

Items 67 to 71.—Procedure at the Board Meetings.—The Government of India have generally approved the proposals put forward by the Board and have left the practical methods of the procedure to be followed at the meetings of the Board to the experience of the Board.

As regards the inquiry into sugarcane which forms the principal subject for the discussion at this meeting of the Board, Mr. Barber kindly prepared a scheme for Provincial inquiry. The notes submitted by the Provincial Departments on the subject are appended (see Appendix II, page 81).

Items 72 and 73.—Place of Meeting.—The Government of India have approved the recommendation of the Board that its meeting should be held in alternate years at Pusa and in the Provinces.

Item 75.—The form of degree or diploma.—The question of the form of the degree or diploma to be conferred by provincial Agricultural Colleges is still under the consideration of the Government of India. They have promised to address Local Governments separately, if necessary.

F. G. SLY,

Offg. Inspector General of Agriculture in India and President, Board of Agriculture in India.

Note on the prospective sugarcane experiments by Messrs. J. W. Leather and E. Shearer.

The cultivation of varieties of cane at Pusa has led to the following as being the more important question which we should try to answer —

(*a*) *Date of Planting.*—The cane was planted in March of the current year and we think two dates, approximately October and February, should be tried with a thin variety and a thick variety in order to note any advantages which might accrue from the one or the other. Judging by the present crop, it seems likely that some cane can be obtained mature from the end of October and it is of importance to ascertain over how long a period cane can be brought to maturity.

(*b*) *The depth at which sets should be planted* should probably depend on the moisture conditions of the soil. Where the sets are put into freshly irrigated land, as in black cotton soil tracts, there can be no object in putting the sets deep. But where the cane is planted without irrigation, as in Behar, it is an open question whether sets should not be covered with several inches of loose earth. It is proposed to plant several varieties with two distinctly different amounts of earth over them.

A similar question is whether the present Behar plan of preparing a trench beforehand is the most desirable. A great part of the moisture which was in the removed earth and some of that from the bed of the trench is lost. We therefore propose to plant some two or three varieties in pits, made *at the time of planting*, as a means of testing the question. An irrigation channel will be

made afterwards along the line of pits. The whole of the earth dug out of the pit will be replaced together with the manure.

In this connection also it seems possible to do all the cultivation required for cane by bullock power only. With the implements at present at our command we can cultivate to a depth of 9 inches and if necessary subsoil stirring could be done in addition. The question of bullock power for cultivation is important because of the cost of manual labour and also the difficulty of getting the requisite amount of labour at a busy season. We therefore propose to plant an area of not less than ½ acre to 1 acre by bullock power only.

(*c*) *The distance between rows of cane* has been 5 feet up to the present. Mr. Barber has found 4 feet sufficient and we propose to plant two or three varieties at this latter distance between rows and two or three varieties of thin canes at 3 feet 6 inches. In the experiments with pits these will be 4 feet by 3 feet apart.

(*d*) Some of the canes this year have been unable to support their own weight and have fallen. In the coming year some varieties will be bound by the lower leaves as soon as these commence to fade and this binding will be continued upwards; finally, when the later stages of growth have been reached, three or four stools will be bound together at the upper part.

APPENDIX C.

PROGRAMME OF THE IMPERIAL DEPARTMENT OF AGRICULTURE FOR 1907-08.

PROGRAMME OF THE AGRICULTURAL RESEARCH INSTITUTE, PUSA.

The scientific work of this Institute for the coming year is indicated in the programmes submitted under the different sections.

The construction of the buildings sanctioned by the Government of India has practically been finished with the exception of the Phipps' Laboratories. The stone and brick work in this building will continue for some months longer. The furnishings and fittings, as well as the erection of electric and gas installations, will also take to the end of the year, so that it is calculated this important building should be ready for occupation in January 1908.

Probationers from the provinces to the number of 17 have been taken for training during the past year, and now that the hostel is finished this number can be increased if it is necessary.

The curriculum of studies will be prepared by the Inspector General of Agriculture in India and the staff.

Books to the value of R22,000 have been purchased for the Library and Reading-room. A catalogue is in preparation and will be issued shortly.

The publications from this Institute during the past year, besides the usual annual report, have consisted of a quarterly Agricultural Journal of India and Memoirs on various scientific subjects. It is intended to continue this work.

B. COVENTRY,
Director of the Agricultural Research Institute and
Principal of the Agricultural College, Pusa.

I.—AGRICULTURAL CHEMISTRY.

1. *Available plant food in soils.*—The programmes of 1905 and 1906 contained references to a series of experiments on the determination of readily available plant food in soils. The subject has been limited mainly to a test of the value of Dyer's method for the estimation of available phosphates and potash, and for the most part only one natural order of plants has been so far included. The experiments have consisted in (*a*) the testing of soils by Dyer's method in the laboratory, and (*b*) the growth of plants in the same soils both with and without additions of fertilisers in the pot-culture house. The work was much handicapped at Dehra because the shed in which the pot-cultures were made was unsuited to such work, and insects and rats and fungi spoiled some of the cultures A very well equipped house has been constructed a Pusa, and the work is under good control.

Altogether nine soils from various parts of India have been included, and the several years' work has resulted in a very good confirmation of the value of Dyer's method for the estimation of available phosphate, so far as the growth of cereals is concerned. The data for potash was not so certain. The more definite results are about to issue as a Memoir.

Future experiments will include natural orders of plants other than the gramineæ. I intend also to apply the information which we have obtained to a certain area of Behar, which judging by analyses of odd samples, is a fairly well defined and large area deficient in phosphates, but how soon this can be taken up must depend on other calls of my time and my staff. It is obvious, however, that if areas of land exist which possess special features, their geographical limits and properties should follow as a practical outcome of such experiments as those referred to.

2. *Rain and dew.*—As mentioned in my two previous programmes, the amount of nitrogen compounds has been determined in rain water (collected at Dehra Dun and at Cawnpore) and in dew (collected at Cawnpore) over one year in each case. The data obtained were published as a Memoir of the Department this year. The result was to show that Indian rain does not

contain any inordinate quantity of such compounds; in fact the series of specimens which were examined contained no more than has been found in England. The amount of nitrate was relatively higher and that of ammonia relatively lower at Dehra, and this may perhaps be due to electric phenomena, but the popular notion that our rainfall forms an important supply of such plant food is clearly negatived.

A similar series of records is being kept at Pusa, but if any novelty is met with, it will lie in other directions.

3. *Drainage.*—The subject of drainage was also referred to in my previous programmes. During the past year four rain gauges, two of 3 feet and two of 6 feet thick and 1/1,000 acres in area, have been constructed at Pusa, and I wish here to mention that we are under obligation to Mr. M. H. Arnott, the Superintending Engineer in charge of the works, for the interest which he took in their construction. If these gauges are to yield really satisfactory data, they must contain only undisturbed soil, and Mr. Arnott constructed those at Pusa quite successfully, the earth being not only undisturbed land but also quite free from cracks. They were completed before the commencement of the rains, but the measuring apparatus was only fitted up later, and imperfect records were all that could be maintained this year. The drainage water was tested for nitrate and it was found to be almost free of this constituent. This was anticipated from a previous examination of the soil. In this respect our gauges are very different from those at Cawnpore. Two of them carry *dub* grass (*Cynodon dactylon*) and two are maintained fallow, and for the coming year they will be kept in this state.

The similar gauges at Cawnpore continue to yield most interesting drainage water. Through the kindness of Messrs. Moreland and Hayman I have been supplied with samples throughout three monsoons, and the concentration of the nitrate in water continues undiminished. Moreover the total quantity of nitrate this year (one of heavy rainfall) has been greater than even that of 1901. This quantity is naturally not to be confused with the concentration. It varies like the quantity of drainage, with the rainfall.

4. *Water in soils.*—As mentioned in my last programme, a record of the amount of moisture in the soil throughout the year was to be maintained. This has been done since February down to a depth of 5 feet from the surface.

The apparatus employed has not been publicly described. I intend to do this during the coming year, but it may be briefly stated that a specimen of the undisturbed soil is obtained and weighed without any such loss of moisture as would affect the required accuracy of the experiments. The soil is then dried and the moisture estimated by difference. From the first borings it became perfectly evident that accurate as this information is, other data would be necessary. The percentage of water was found to vary in a quite unexpected degree, and this could only be referable to differences in the physical nature of the different strata. Accordingly it was necessary to add to the foregoing "percentage determination" of the amount of water, a careful physical examination of the different strata. This is a most tedious and time-absorbing matter and has delayed the work in a measure But one result has been clearly defined, which is that, after percolation has ceased, the quantity of water present in any volume of soil is dependent primarily on the physical character of the soil, and that, within a few inches there can be a variation from 8 or 10 per cent. up to as much as 20 per cent. of water. This is in full agreement with the opinions on the subject of soil moisture which Mr. Lyman Briggs of the United States Agriculture Department expressed several years ago. It also shows the futility of expressing the quantity of water in soil simply as a "percentage." There is every reason to expect that it will be possible to publish some very interesting data during the year.

6. *Soil gases.*—During the last few months I have perfected an apparatus which enables one readily to determine the quantity and nature of the gases contained in soils at various depths. It is a subject which has occupied my thoughts for several years, but which for technical reasons I was unable to submit to experiment until I came to Pusa. At present there is no very precise information on this matter in any country.

6. *Cyanogenetic glucosides.*—It has been decided that the work at Pusa on this subject shall be restricted to an enquiry into the conditions under which

these glucosides are formed in plants. So far no success has attended the experiment. I have failed to grow sorghum containing any material proportion of dhurrin, but further experiments will be conducted during the coming season. Linseed, another plant in which a cyanogenetic glucoside is formed, is now growing at Pusa, and it contains very considerable quantities, but the conditions of the formation are still unknown.

7. *Manures: Calcium Cyanamide and Calcium nitrate.*—These are the two substances which have during very recent years been prepared by bringing atmospheric nitrogen into combination with lime and carbon or oxygen respectively. Their nature has been sufficiently made known in various agricultural journals. Both have been employed in my pot-culture experiments, and I hope to see them used in field experiments very shortly. The question of cost is naturally a very important one, but judging by figures published in Europe, their nitrogen is already as cheap per pound as that in either Chili saltpetre or sulphate of ammonia. I need only add that I have found no deleterious effects to follow the use of the cyanamide.

8. *Field experiments.*—A separate note on some field experiments, which will extend over a series of years, will be submitted by Mr. Shearer and myself in January.

9. *General analytical work.*—Owing to the appointment of Chemists to the Provincial Agricultural Departments, the number of odd specimens sent for general analysis is likely to decrease, and indeed it has done so in a measure already. As a result there is not only more opportunity for the prosecution of various investigations but it is also possible to organize the work more perfectly. Hitherto it has been almost essential to give preference in a great measure to analyses of provincial samples, and this has not enabled me to detail one assistant to any one specific work. But with the decrease of such odd analyses, this more perfect organization will become possible.

10. *Probationers.*—Three probationers from provinces have been accommodated in the Pusa Laboratory during the past year. During the current year several of the newly appointed Chemists to provinces are to spend some months at Pusa, and the small temporary laboratory will be very fully occupied.

J. WALTER LEATHER, PH. D.,

Imperial Agricultural Chemist.

II.—Economic Botany.

1. *Plant breeding and plant improvement.*—During 1907, the following crops will be studied: wheat, tobacco and barley. The determination of the varieties of Indian wheat, tobacco and barley will be continued.

2. *Fibre plants.*—The collection and investigation of fibre-yielding plants will be continued.

3. *Fruit experiments.*—The permanent experiments on the culture of Indian fruits will be continued on the lines laid down in the first report.

4. *Minor investigations.*—The study of the varieties and cultivation of cassava. The Imperial Agricultural Chemist will determine the amount of glucoside and starch. The economic importance of the male plant in *ganja* cultivation.

5. *Publications.*—The monograph on Indian wheat will be completed.

A. HOWARD, M.A.,

Imperial Economic Botanist.

III.—Mycology.

1. *Training.*—The training of provincial probationers in Mycology will be continued. The probationers from Bengal and the Central Provinces will finish their course, and new men will be received from Madras, the United Provinces, and possibly another province. A period of about 18 months will be required in each case.

2. *Research and experimental work* (*a*) *Soil fungi in relation to plant life.*—A number of the commoner fungi found in decomposing organic matter in Pusa have been isolated. Fresh collections are made from selected localities so as to ascertain the relative frequency at different seasons of the different species. This must be continued over some years. The effect of these in pure culture on dead vegetable tissue will be tested, as soon as a sufficient number of constantly recurring forms have been obtained. The work on Mycorhizas or the association of fungi with living plants will be continued.

(*b*) *Wilt diseases.*—The efforts to obtain a resistant strain of pigeon pea (*arhar* or *tur*) are showing considerable promise at Bombay. The selected seed from the disease-infested plot at Kirkee Farm has this year given a crop with at least 75 per cent less diseased plants than last year's crop. This work will be continued. The similar experiments at Pusa were lost owing to the floods. No infections were carried out at Pusa for the same reason, but fresh arrangements will be made for the coming season.

(*c*) *Sugarcane diseases.*—The plots at Pusa were flooded in August and the experiments lost. Sufficient growth had, however, occurred to illustrate the good effects of seed selection. This work will be repeated and fresh experiments started.

(*d*) *Crop rusts.*—The work at Cawnpore, in conjunction with Mr. Hayman, to ascertain the origin of wheat rust each season will be continued. About 100 plants in all have been grown under protection from outside infection without developing rust. A considerable number will again be grown in the cases under varying and better controlled conditions. It is proposed to repeat at Pusa some of Dr. Eriksson's cytological work, which is in want of confirmation. The investigation of other crop rusts may be taken up if occasion arises.

(*e*) *Smuts.*—The life history of some Indian smuts is being investigated and work on these will be continued.

(*f*) The identification and study of other fungus diseases of crops will occupy, as usual, a large amount of time.

3. *Systematic work.*—Arrangements have been completed for the identification of most of the species of fungi which have been collected during the last five years. The necessity for this work, which cannot be satisfactorily done in India, is apparent from the first large collection dealt with, that of the rusts and smuts. Though these parasites have had more attention paid to them by previous workers in India than any of the other groups of fungi, one new genus and forty-two new species were contained in a first collection of one hundred and forty-three specimens recently worked out in conjunction with Herr Sydow at Berlin. Other groups will be taken up in turn.

E. J. BUTLER, M.B.,
Imperial Mycologist.

IV.—Entomology.

The work of the past year in studying and advising on insect pests will be continued; assistance will be given in directing the work of provincial assistants until the appointment of Entomologists to provincial departments. This work will occupy the major part of the time and no new investigations of an extensive nature are proposed. The enquiry into insecticides, non-poisonous to cattle, will be continued. The results gained with the re-introduction of parasites of the cotton bollworm to the Punjab justify a continuance of this work which will probably restore normal conditions. The value of trap crops will be studied as opportunities permit on the Pusa Experimental Farm. Some progress has been made with the investigation of biting flies, and it is proposed to continue this and to publish the preliminary results. It will be necessary to continue the work of the insect survey of the plains of India with a view to the identification of common insect pests and their allies. Should the appointment of provincial Entomologists lessen the mass of routine work, it may be possible to commence the study of the parasitic enemies of pests with a view to an extension of this method to pests other than the bollworm of cotton in the

Punjab. In co-operation with the Madras Agricultural Department, it is hoped that it may be possible to investigate the insect pests peculiar to Southern India. A method of checking the migratory locusts will be tested in co-operation with the Punjab Agricultural Department; should there be any extensive occurrence of this pest, other work will be dropped in favour of the more careful study of this important insect.

H. MAXWELL-LEFROY, M.A.,
Imperial Entomologist.

V.—Agricultural Bacteriology.

As this officer will be on deputation during the coming year, no programme is submitted.

VI.—Agriculture.

1. The initiation of a series of permanent field experiments in conjunction with the Imperial Agricultural Chemist, a note on which will be submitted separately.

2. *Sugarcane.*—The cultivation of the selected varieties will be continued.

3. *A systematic trial of the efficiency of field agricultural implements—native and foreign in use in India.*—An attempt will be made to estimate the co-efficient of friction in each case and to work out the draught in foot-pounds.

4. *Experiments with cotton, annual and perennial.*—These were initiated by the Inspector General of Agriculture in 1904. In the case of the annual cotton, the design was to discover or produce a superior cotton, indigenous or exotic, suitable for cultivation in Behar. Many tree cottons were collected and grown with the same end in view. The work has, up to the present, been largely a failure, but will be continued on the lines originally laid down.

5. *Training of probationers.*—Will be continued as at present.

E. SHEARER, M. A.,
Imperial Agriculturist.

APPENDIX D.

PROGRAMMES OF PROVINCIAL DEPARTMENTS OF AGRICULTURE FOR 1907-08.

BOMBAY.

I.—AGRICULTURAL STATIONS IN CHARGE OF THE DEPUTY DIRECTOR OF AGRICULTURE.

Serial No.	Name of Station.	Situation.		Tract represented	Area in acres.	Types of soil	Date when established	Height over sea level.	Average rain fall inches	Temperature.	
		North Latitude	East Longitude.							Maximum.	Minimum
1	Surat .	21°12′	72°52′	South Gujarat	172 (88 newly acquired in 1906).	Black Cotton.	1896	about sea level.	39	103°	47°
2	Nadiàd .	22°44′	73°0	North Gujarat.	44	Sandy (Goradu).	1903	Do.	33	114°	50°
3	Dhàrwár .	15°27′	75°6′	Karnatak	74	(a) Black Clay (b) Red Sandy.	1904	2580 ft.	32	100°	51°
4	Dhulia .	21°10′	75°20′	North Deccan.	28	Medium black.	1905	844 ft.	22	112°	37°
5	Mirpurkhas.	25°32′	69°2′	Sind .	47	Sandy alluvial loam.	1904	about sea level.	6	120°	40°
6	Muvália .	22°50′	70°18′	Panch mahál.	58	Part reds Part black.	1906	...	30	108°	44°

In addition land has been acquired (66 acres) for a farm to be irrigated from the Gokák Canal (Belgaum District).

2. *Continuous investigations* are being conducted on the manurial and cultural practices of the cultivators in the several districts of which the conditions on the above stations are typical. New methods and artificial manures are being tried in comparison.

3. *Selection* of following crops is a part of the work of all stations on which they are grown, *viz.*,—Cotton, Jowár, Bàjri, Wheat, Tuer, Til, Groundnut, etc.

4. *Foreign varieties* of these crops are being tried.

5. *Cotton breeding* is being extended.

6. *Wheat breeding* is being initiated.

7. *The Cotton survey* of the Presidency is being continued and where mixtures are grown, these are analysed.

8. The survey of the *cottons of the world* is almost complete.

9. *A wheat survey* is similarly being initiated.

10. *Groundnut disease* (Tikka) is now being taken up.

11. *Disease proof potatoes* are being sought for (Dahàrwár).

12. *Tobacco cultivation and curing* are being investigated (Nadiád.)

13. *The spice gardens* of Kanara are being experimented on with regard to the question of leaf mould.

14. *Land Reclamation* is being attempted under 3 sets of conditions.

15. *Irrigation* on several of the stations is a subject of experiment both as regards quantity of water to be applied and method of raising it.

16. *Insects Pests* are being investigated.

17 *European ploughs* are being indented for by cultivators and are supplied at cost price.

II.—Agricultural Stations in charge of the Professor of Agriculture.

Serial No.	Name of Station	Situation.		Tract represented	Area in acres	Types of soil	Date when established	Height over sea level	Average rain fall inches.	Temperature.	
		North Latitude	East Longitude.							Maximum	Minimum.
								ft.			
1	Manjri. (near Poona)	18°30'	73°59'	South Deccan	62	Medium black.	1891	1850	27	108°	40°
2	Poona (Kirkee)	18°30'	73°50'	Do	66	Do	1879	1850	30	108°	40°
3	Lonávala	18°15'	73°27'	West Deccan.	25	Light	1904	2039	186		
4	Poona Agricultural College.	18°30'	73°50'	South Deccan.	130	Light and Medium black	1905	1850	30	108°	40°
5	Poona Dairy and Farm.	18°30'	73°50'	Do.	+	Medium black.	1892	1850	30	108°	40°

+ Included under No 2.

Manjri Station.

Mánjri station is a Sugarcane Farm. A comprehensive series of experiments has been drawn up by a Committee composed of the expert officers of the Department and the Director.

Rotations suitable for the block system of irrigation, manurial tests, including fallowing, green manuring, application of farmyard manure and castor cake, farmyard manure and fish manure, farmyard manure and safflower cake, in varying proportions; farmyard manure, farmyard manure and sulphate of potash, farmyard manure and ammonium sulphate, farmyard manure and crude nitre.

In all cases, the quantity of manure is to be measured by bulk as well as in terms of its chemical constituents instead of solely in such terms as in previous experiments.

Cotton and jute under irrigation are to be tried. Irrigation experiments will be continued.

Poona Station.

Poona Station is small and irregular. Dr. Butler has a series of experiments with groundnut Tikka disease, and one with Tur wilt which will be continued.

Trial of new varieties and growing of fodder for the Dairy complete the work of the Station.

Lonavla Station.

Lonavla rice experiments are to be continued. The principal line of work is to investigate the principles upon which the efficiency of rab depends, and to find a suitable substitute.

Some work in making a survey of the rice varieties has been begun.

Poona Agricultural College Station.

College Farm is purely for demonstration.

Poona Dairy Station

The Dairy is run on commercial lines.

III.—Agricultural Stations in charge of the Economic Botanist.

Serial No	Name of Station	Station		Tract represented.	Area in acres	Types of soil	Date when established	Height over sea level	Average rainfall inches	Temperature	
		North Latitude	East Longitude.							Maximum	Minimum.
1	Ganeshkhind gardens.	18° 30′	73° 50′	South Deccan.	80	Medium black and light murum.	1904	ft. 1850	30	105°	40°
2	Bassein gardens.	19° 20′	72° 51′	North Konkan.	90	Sandy alluvial loam.	1906	About sea level	83	92°	56°

Ganeshkhind Gardens.

1. A systematic collection of indigenous trees and shrubs to determine (among others) the following facts:—

(I) The most satisfactory methods of reproduction, transplanting and treatment during growth.

(II) The periodical increment of growth.

(III) Periods of leafing, flowering, fruiting and ripening of seed.

(IV) Age at maturity.

(V) Special investigations regarding the quality of timber, yield of the other economic products, etc.

2. Experimental introduction of rubber, fibre, medicinal plants, etc.

3. Experimental tests on exotic plants on the same lines as (1) and (2).

4. Endeavours to increase and to improve the yield of fruit trees, indigenous and also exotic, if found suitable for the Deccan.

5. Botanical research, in special natural orders, the first three to be undertaken being Malvaceæ, Leguminosæ and Cucurbitaceæ.

6. To continue the cultivation of cottons for purposes of botanical classification, also of wheat and rice.

7. To attempt the improvement of a selected number of our finest wild flowering plants so that they can be used as garden plants.

Bassein Gardens.

Programme of work as in the Ganesh Khind Botanical Gardens with special reference to conditions in the Konkan. While the Fort is being cleaned advantage is being taken to study the best local methods.

United Provinces of Agra and Oudh.

The following are the principal subjects of investigation at the different agricultural stations:—

1.—Cawnpore.

A.—Manurial experiments.

1. The permanent series with wheat and maize.
2. Trial of artificial manures on cotton.
3. Comparison of neem-cake, cotton refuse, and poudrette on the yield and quality of potatoes.
4. Long-term experiment with green-manuring.

B.—Variety experiments.

5. Varieties of early ripening *arhar* (*Cajanus indicus*) as a protection against frost.
6. Trial of a variety of maize as a fodder crop.

C.—Study, improvement and selection of crops.

7 *Wheat.*—Completing the provincial collection and record of local information as to relations of varieties to soils, resistance to rust and drought, baking

qualities, comparative prices, export demand, and local estimation in which each variety is held. Hybridization.

8. *Cotton*:—

(i) *Indigenous.*—Botanical study of the local varieties; examination of the relative proportions of different types as commonly sown together. Extent of variation in these types. Their selection and trial from an economic point of view.

(ii) *American.*—Introduction of the longer-stapled American variety (*G. hirsutum*, Mill.) with arrangements for securing to the cultivator its full market value.

(iii) *Indian.*—Study of the changes which take place in certain types of Indian cotton when brought to this Province and grown under conditions to prevent any possibility of cross-fertilization.

(iv) Hybridization.

9. *Poppy.*—Selection.

10. *Rice.*—Cross fertilization of two varieties, to meet the ravages of the rice-sapper (*Leptocorisa acuta*) and obtain a rice of good quality with the protective qualities of a coarser variety, in which the head remains in the sheaf until maturity.

D.—Other investigations.

11. Nitrogen investigations, including examination of drainage-waters and a set of rotations designed to indicate the effect on the fertility of the soil of different forms of cropping customary to the province, and to ascertain how far the benefits following a gram crop are due to nitrogen collection and how far to crop variation.

12. *Rust.*—Joint work with the Imperial Mycologist in an enquiry as to the origin of rust, its earliest appearance, possibility of the disease being carried over by volunteer crops, and selection of rust-resisting varieties carried out under conditions conducive to rust.

13. *Seed inoculation.*—Pot experiments carried out as a check on the field experiments at Orai Station.

14. *Irrigation.*—Arrangements for determining the seepage of water in field channels, and the average quality of water required at different seasons of the year for different crops in the *duab* soils.

15. Trial of fodder crops for growth in seasons of scarcity.

16. Entomological records.

17. Incidental investigations such as testing plots for experiment, determining residual capacity of old manurial plots, etc.

II.—Orai.

1. *Cotton.*—Botanical examination of cotton collected from different parts of Bundelkhand, examination of the relative proportions of different types as commonly sown together: selection and trial from an economic point of view.

2. *Wheat.*—(i) Attempt to select a rust-resisting wheat conducted under special conditions conducive to rust, and with seed obtained from all parts of the Province.

(ii) Trial of wheats bred at Cawnpore as to suitability to the locality and resistance to rust.

3. *Linseed.*—Work as in connection with selection of wheat, Russian, Dutch, Australian and country varieties under trial.

4. *Juar.*—Classification of Bundelkhand juars and enquiry into the local varieties most suitable for distribution locally in times of need.

5 *Ground-nuts.*—Trial of Japanese, American, Spanish and Bombay varieties on light land under irrigation.

6. *Kans.*—Trials of methods of eradication.

7. *Fodder-supply.*—Propagation of spineless cactus and other plants on waste land.

8. *Seed inoculation.*—Inoculation of gram on poor soils.

9. *Tillage.*—Study of implements for Bundelkhand soils.

III.—Aligarh.

This station lies in the centre of the cotton tract and is designed mainly for improvement of this crop. The station was only opened in June 1906 and this year's programme of cultivation is preliminary. The lines of work proposed are:—

(1) Study and selection of the local cotton, and enquiry as to the local trade demand.
(2) Methods of sowing and interculture.
(3) Introduction of an improved cotton, if possible American Upland with arrangements to secure for cultivators the value of the quality.
(4) Trials of implements and water-lifts.

IV.—Partabgarh.

This station, too, was opened only in June 1906. Its specialities will be rice and sugarcane, but for the present the cultivation is designed only to get a knowledge of the soil and conditions.

The distribution of seed on credit and the demonstration of methods of sugar manufacture are conducted from this station.

Other lines of work which are being taken up are:—

(1) Introduction of maize in the locality.
(2) Improvement of the ravine-systems as grazing grounds.
(3) Preliminary trials of ammonium sulphate on sugarcane.

V.—Reclamation Stations.

The arrival of the Agricultural Chemist is awaited before revising the present programme. The railways having quoted a low special rate for gypsum an experiment is being undertaken with an area which is at present just too alkaline for cultivation.

VI.—Well investigations.

The well survey continues. The facts of each village in the Province are now on record, except in a few districts, and the villages where irrigation is defective are being classified according to their needs.

Borers have been placed under Collectors in the majority of districts to assist in locating sites for wells. The investigations still in progress relate to:—

(1) The best form of percolation well for fine sand in localities where springs do not exist.
(2) The most practicable way of increasing the supply in the rock-wells in the south of the Provinces.
(3) The safe employment of oil-engines or other power lifts in spring wells in the alluvium.

Bengal.

1. The experiments on (*a*) paddy, (*b*) jute and (*c*) potatoes that are being carried on at the Burdwan Agricultural Station will be continued.

2. The experiments on (*a*) *aman* paddy, (*b*) *aus* paddy, (*c*) jute, (*d*) potatoes and (*e*) groundnuts that are being carried on at the Cuttack Agricultural Station will be continued.

3. The experiments on (*a*) sugarcane, (*b*) wheat, (*c*) mustard and (*d*) paddy will also be continued at the Dumraon Agricultural Station.

4. The two agricultural stations newly started at Bankipur and at Sabaur, near Bhagalpur, will be brought into working order.

5. Another new agricultural station will be started during the year.

6. The production of jute seed at Purnea, Chinsurah and perhaps Berhampur will be continued.

7. The work in connection with the cultivation of *Buri* cotton in the Chota Nagpur Division will be extended. A special farm will possibly be opened for this purpose, in addition to encouraging the cultivation of this variety among private cultivators.

8. The working of the Tasar Silk Farm which was started in April last at Chaibassa will be continued.

Madras.

The general programme sketched in Board's Proceedings No. 6857 *Miscellaneous of 20th November 1905, will be followed during the year 1907.

The following brief note is forwarded on the work proposed for 1907.

1. The attention of the Government Botanist was mainly engaged in the investigation of the haustoria of the sandal-wood tree, on which subject two papers have been issued.

The wild peppers of Southern India are still being studied, and a collection has been made of the flora of the Government pepper farm at Taliparamba (Malabar). A collection of lemon grass was made and some plants sent to the Director of Botanical Survey, Calcutta. An attempt was made to send some lemon grass plants in wardian cases to Barbados through Kew, but the plants died before reaching Gibraltar. Seeds are now being collected on the Taliparamba farm and will be sent by post direct to the West Indies.

2. The study of the root parasites of the sandal has been finished, and the haustoria of *Cansjera*, *Olax*, *Ximenia* and *Opilia* are now being studied by the Government Botanist. A collection of other root parasites such as *Striga*, *Æginetia peaunculata Nicotianæ*, etc., is also being made. A special Agricultural Inspector is now engaged in collecting material for a report on the sugarcane cultivation of the Presidency. This will be completed during the current year.

3. The Mycological Assistant is on special duty in connection with the experiment which is now being made to arrest the spread of the palmyra disease in the Godavari District.

4. The Imperial Entomologist paid a short visit to Madras in December last, and has kindly undertaken to frame a definite programme of work for the Entomological Assistants during the coming year. It is also hoped that Mr. Lefroy may be able to spend a portion of the current year in the Madras Presidency in investigating the Entomology of Southern India.

5. The tillage and manurial experiments described in last year's note will be continued, and in the case of cotton an attempt will be made to extend the cultivation of the pure Karunganni cotton in Tinnevelly by the selection of a quantity of pure seed, which will be distributed to the ryots under agreements. The addition of a black soil area to the Koilpatti farm will also permit an increased supply of pure seed to be raised for distribution to the ryots who showed much appreciation of the selected seed distributed to them last season. It is at present intended to concentrate the efforts of the Agricultural Department in Tinnevelly on extending the growth of pure Karunganni.

6. Experiments in long-staple cottons will be continued at Attur and Taliparmba, and at the new farm at Nandyal in the Kurnool District the "northerns" cottons will be investigated. Simultaneously, the sorghums usually grown in Kurnool in rotation with cotton will be specially studied and attempts made to improve them by seed selection and introducing a leguminous crop into the rotation. Indigo will be tried in the first instance, as this crop is still extensively grown near Nandyal.

7. *Sugarcane.*—The Mauritius canes found most satisfactory at Samalkota have been introduced into the Chingleput and South Arcot Districts at Melrosapurum and Palur, and a considerable number of canes will be distributed to the ryots of the neighbourhood for the approaching season. A nursery on dry land will be opened at Samalkota in the coming season for the supply of seed canes to the ryots of that district. Some additions have been made to the collection of canes at Samalkota which now comprises 38 varieties.

8. *Jute.*—Serajgunj and Howrah jute were introduced during the year at Samalkota and *sunn* hemp and *gogu* are being tested along with them. The fibres have been sent to Calcutta for valuation. The same three fibre crops were also attempted on the Taliparamba farm in Malabar. The jute and *sunn* hemp in Malabar is poor, but the *gogu* promises well. All these experiments will be continued during the current year.

9. *Ground nut.*—The Palur farm has been put on a permanent footing and a regular series of experiments has been laid down to test the different varieties against the local Mauritius which now holds the field. One plot of permanent ground nut will be laid down with a view to test the effect on the soil of continuous cropping with ground nut without manure.

* Printed on pages 129—133 of the Proceedings of the Second Meeting of the Board of Agriculture, 1906.

10. The Hagari Experimental station is being laid out for the irrigation experiments on black cotton soil. Cotton and paddy are the two crops selected for experiment at first, and it is hoped that most of the area will be brought under irrigation in the course of the year.

11. *Tobacco*.—The curing experiments undertaken by Messrs. Spencer and Company at Dindigul will be continued. In September last a small quantity of light wrapper Sumatra tobacco seed was obtained from Borneo and is being grown near Cocanada and some American varieties are being grown for seed on the Koilpatti farm.

12. *Paspalum dilatatum*.—Is being tried at several stations, and is doing well at Hagari in black cotton soil on the outer slopes of irrigation channels. Experiments are being made by the Forest and Revenue Departments and it is hoped to summarize the results of these early next year.

Punjab.

1. The measures to be adopted for the prosecution of the campaign against cotton boll-worm in 1907, are under consideration at the time of writing. The operations for the improvement of indigenous cotton will be persevered with. They have not met with any particular success up to the present, but adverse seasons and paucity of staff may be partly accountable for this. A scheme has been submitted to the Local Government for a systematic survey of the Province with reference to the possibility of extending irrigation by means of embankments, water-channels and wells, and also for rendering scientific assistance to cultivators in carrying out minor works of irrigation It is probable that a start will be made next winter. Entomological work will be continued, the chief subjects being locusts, and sugarcane, cotton and oilseed pests.

2. The equipment of the Lyallpur College and Research Institute, the framing of a curriculum and prospectus, and the recruitment and training of the members of the native staff, will claim the attention of the Principal and of the Agricultural Chemist. The Chemical Laboratories should be ready by the autumn, and by that time a considerable amount of work should be ready in connection with the "reh" investigation referred to in the next paragraph.

3. The Deputy Director of Agriculture will be occupied with the distribution and improvement of acclimatised American cotton in the Jhelum and Chenab Colonies; 1,500 acres were sown in 1906, and a substantial increase is expected in 1907. There will be further trials of Egyptian cottons in the South-West Punjab (the Dera Ghazi Khan and Muzaffargurh District). The results obtained in 1906 were inconclusive. An experimental farm will be established and organised at Jullundur. An enquiry into "reh" has been undertaken in the Chenab and Jhelum Colonies with a view to the reclamation of "usar" soils. Miscellaneous work includes the introduction and trials of new varieties of crops, *e.g.*, Java indigo, small demonstrations of machines, and so forth.

4. The Lyallpur Agricultural Stations will be extended to 500 acres, the extension being for seed growing and demonstration. Owing to the inconclusive nature of many of the results hitherto obtained, special attention is being given to testing as large an area as can be spared by weighing the produce of the same crop and variety grown under uniform cultivation without manure on each plot. The comparative experiments will be slightly curtailed for the present, and the hydraulic experiments are temporarily unavoidably discontinued. Experiments will be made in growing cotton on ridges so as to facilitate interculture and prevent water-logging—a system which has been very successful on a small scale in the past year. The experiments and operations with wheat and cotton and other crops will be on the same lines as before. Selected varieties of wheat and cotton will be grown for seed distribution. A trial will be made with jute.

5. The Sargodha Seed Farm is now well stocked, and will have large quantities of good wheat and cotton seed for sale.

Burma.

The Department in Burma has hardly as yet taken shape. I returned from leave and assumed charge as Director on the 15th of October 1906. Prior

to this Mr. K. D. Shroff, B.A., had been appointed Assistant to the Entomologist and had been devoting his time up till the date of my arrival to collection and classification of insects and to the study of Burmese. Without efficient equipment and supervision, but little progress has been made. The Agricultural Chemist—Mr. F. J. Warth, B.Sc., arrived on the 29th October. None of our laboratories have as yet been begun and I had great difficulty in getting him accommodation. The Principal of the Rangoon College has kindly offered some help and Mr. Warth has had an opportunity of seeing how Chemistry is taught there. As he has already done some work on laterite, I put him on to an examination of the laterite belt of Lower Burma with special reference to the surface soil, and the question of its manurial treatment. At this stage (early in November), it is proposed that Mr. Warth should be sent to Pusa for a time. On his return I propose to put him on to an examination and analysis of the soils of the selected Farms. He will also draw up elementary text-books on the lines of the syllabus suggested by last year's Conference.

Up to the time of writing an Agriculturist and Botanist have not arrived nor is it known when they may be expected.

It may be added that excepting for the acquisition of land for Experimental Farms at Mandalay and at Hmawbi (near Rangoon) nothing further has been done. No buildings have been erected and further work awaits the receipt of orders on the whole scheme.

In these circumstances nothing has been done up to date and it can hardly be expected that much in the way of definite work will be possible during the coming year. Assuming, however, that I shall shortly have a full staff, I shall employ them as follows:—

The Agriculturist will be as much out on tour as possible, studying local crops and local methods of cultivation. I shall endeavour to accompany him as often as possible. For this year the crops which he might especially take up would be rice, tobacco, cotton and wheat (with a view to the survey of existing varieties suggested by the last Board of Agriculture, both in the case of tobacco and wheat).

The Botanist would also be out as much as possible, making collections of the various plants of the country and would work with the Agriculturist on the survey of wheat and tobacco.

The Chemist will, as above indicated, complete his work on the laterite tract which forms a large and important one and would then take up an analysis of the soils of the two Experimental Farms: all with reference to manurial experiments.

The Assistant to the Entomologist—I should be obliged if Mr. Maxwell Lefroy would kindly work out a scheme of research for this officer. I would suggest a study of the rice, tobacco and cotton pests.

The Director.—As far as I can see my work for the next year will principally be concerned with organization of establishment and plans and specifications of buildings. I propose, however, to look into one or two matters. The existing Experimental Gardens want attention Some have served their purpose; some, I fear, have few results to show. I propose to go round as many of them as I can and advise on the desirability of their continuance or abandonment. The question of cattle-shows and the best methods of conducting them requires careful consideration. The Rice-crop. of Akyab is causing a certain amount of alarm amongst merchants and I propose to discuss this matter along with the millers. Rangoon, Bassein and Moulmein will also be visited during the milling season and various questions in connection with the quality and milling properties of the paddy will be investigated.

Next monsoon, even if, as is likely, the buildings are not ready and we have not our complete staff, I propose to work the Farms with hired temporary labour simply on the indigenous methods of the country. This will be better than leasing the land for another year and will also give the staff an opportunity of carefully studying local methods and considering possible improvements.

Central Provinces and Berar.

Farms.

1. There are now four Experimental Farms in these Provinces—one at Nagpur, one at Labandih near Raipur, one at Powarkhera near Hoshangabad, and one

near Akola in Berar. The total area of arable land on the four farms is about 1,100 acres. In addition to this there is a grazing area of about 900 acres in all. These farms serve a double purpose—(1) as Experimental stations at which the general agricultural problems of the Provinces are investigated, and (2) as Central depôts from which selected seed, good bulls and improved agricultural machinery are issued. The Raipur Station is situated in the rice tract, Akola in the cotton tract and Hoshangabad in the wheat tract. The experiments at these stations are devised to solve problems relating to the staple crop or crops grown in the tracts in which they are situated. The crops experimented with at the Nagpur Station are of a more varied type, as are also the crops of the surrounding country. This station, moreover, serves as a College Farm on which the students of the Agricultural College get a general knowledge of all the important crops grown in the Provinces. The experimental work on which the Department will be engaged during the year will fall under the following heads.

Cotton.

2. The chief experiments with cotton will be conducted at Akola. The most promising of the hybrids already bred will be grown on a larger scale and seed selected from the best types of each hybrid. The four different varieties of cotton commonly grown under the name of *jari* or *varadi* will be grown separately and the values of the outturns compared *inter se*, and with the other local varieties. Experiments will also be undertaken to ascertain how far these can be improved in the quality and quantity of their lint by seed selection. Extended experiments will be undertaken to ascertain the yield of long staple and short staple cottons. In the last 30 years coarse cottons have been rapidly displacing long staple cottons, and it is open to question whether the cultivation of coarse cottons is not really the more profitable to the ryot. Other experiments will be devised to decide as to the best spacing distances for cotton plants, the most profitable rotations, the advantages or otherwise of topping the young plants to produce increased branching, and of deep *versus* shallow cultivation. Egyptian and Uplaud Georgian will be sown under irrigation about a month before the rains, as it is believed that, if thus given a longer period of growth, they will mature before the drought and cold nights of the winter, which seem to check their growth, set in. If the experiment proves successful in the experimental stage, it may be possible to grow these on a practical scale under tank irrigation in parts of the Central Provinces.

Wheat.

3. Some preliminary work will be done in classifying the wheats of the Central Provinces. Crossing will be carried out on scientific lines with a view to produce a hybrid that will be immune to disease and possess at the same time good milling qualities. The pure varieties and crosses that have already been experimented with will be tested still further for rust resistance. Questions relating to depth of tillage and spacing will also be investigated. This experimental work will be mostly confined to the Powarkhera Station.

4. Experiments in rice cultivation are confined to the Labandih Station. The four different methods of cultivation are compared, *viz.*, transplantation sowing by previous germination, sowing *in situ* and cross-ploughing (*biasi*), and simple sowing *in situ*. Experiments are also being conducted to ascertain what is the most economical quantity of water for rice on different classes of soil and whether light waterings at frequent intervals are not more economical for the less retentive soils than heavy waterings at longer intervals. The double-cropping tests will also be continued so as to find what are the most profitable crops grow after rice.

Miscellaneous crops.

5. The rotation experiments with juar, linseed, tur, gram, sesamum and other minor crops will be continued. Some new sorghums will be tried and their outturns as fodder crops compared with those already grown. The cultivation of jute, ambari and *sunn* hemp will be continued at the Raipur Station and their fibre-yielding powers compared. At the Hoshangabad Station Russian linseed is being tried as a fibre crop. Experiments are being undertaken with sugarcane and sweet potatoes at Raipur. It is believed that in the black soil of this Division sugarcane especially can be grown at a very handsome profit wherever irrigation is possible. The best canes of the Central Provinces will be tried and others will be introduced from Bombay and Madras.

6. The various series of continuous experiments with locally obtainable manures and imported fertilizers will be continued. An experiment has also been devised to ascertain the best method of saving and conserving cattle-dung and urine. In the manurial experiments with cotton nitrate of soda has this year given splendid results; but it is believed that an application of cattle-dung before sowing followed by a small quantity of this fertilizer as a top dressing immediately after the plants are thinned out would prove to be even more profitable for the cotton crop on black cotton soil. This will be tested during the coming year.

Manurial experiments.

7. The advantages of deep *versus* shallow cultivation for wheat and cotton will be compared. The eradication of *kans* (*Saccharum spontaneum*) will be again experimented on. New implements will be purchased and tried from time to time.

Tillage experiments.

8. The study of wilt in *tur* and rust in wheat will be continued. Thirty-two samples of tur, received from the different districts of the Central Provinces and Berar, and 12 obtained from Bombay Presidency, are being tested for their wilt-resisting qualities. Seed will be selected from those varieties that prove the fittest to withstand the disease, and that seed again sown on a wilt-infested area.

Plant diseases and insect pests.

The two Entomological Assistants have their head-quarters at Nagpur. The senior Assistant spends most of his time on tour so as to investigate the important crop pests of the Provinces. Experiments are made at head-quarters with insecticides especially on pests infesting garden crops.

The demonstration work of the Department will fall under the following heads.

Small farms will be worked by the Department in the more backward agricultural districts with the object of demonstrating better methods of cultivating certain crops, or of introducing new ones.

Demonstration farms.

The three cotton-seed farms will be continued under the supervision and management of the Department as usual. In future these farms will be supplied each year with specially selected seed from the experimental stations, so that no selection on the farms themselves will be necessary, and all the seed grown thereon will be issued to cultivators.

Cotton-seed farms

The use of saltpetre as a manure for irrigated wheat is being demonstrated in connection with tank irrigation. At certain centres practical demonstrations will also be given of the working of the Meagher system of sewage disposal.

Manures.

The method of treating juar seed with sulphate of copper to prevent smut will be taught to all the Revenue Inspectors of juar tracts; they in turn will demonstrate the practice on a large scale to the actual cultivators.

Prevention of smut in juar.

There has been a very great demand for fodder-cutters, winnowers, corn-shellers and improved ploughs of late consequent on their advantages becoming more widely known. Agricultural Assistants will tour in as many different districts as possible with these machines and give practical demonstrations of their advantages.

Improved implements.

The varieties of cane grown, diseases prevalent and methods of cultivation in vogue are being studied with a view to try the best canes as an experimental crop at the Raipur Station. The Assistant Director will tour through some of the sugarcane tracts so as to demonstrate the improved Poona Mill and evaporating pan.

Sugarcane cultivation and preparation of *gur*.

The Agricultural Gazette published monthly gives the results of experimental works and such other information as is likely to be of some practical utility to its readers. In publishing these results a comparative statement is made of the profits to be gained from the particular practice of farming recommended.

Agricultural Gazette.

Agricultural Associations.

The meetings of the Agricultural Associations will be used as another means by which useful knowledge and advise can be disseminated among the cultivators of the Provinces. These meetings will be attended when possible by one of the officers of the Department.

Eastern Bengal and Assam.

The programme of work for the ensuing year falls under the following heads :—

I. Reorganisation of the Agricultural Department.
II. Equipment of Agricultural stations.
III. Experimental work at the Agricultural stations.
IV. Experimental work outside the Agricultural stations.
V. Special work of the Fibre Expert.
VI. Organisation of the Provincial Veterinary Department.

The work to be done under each of these heads is briefly noted below.

I.—Reorganisation of the Agricultural Department.

A separate Director of Agriculture will be appointed for this Province in time to attend the meeting of the Agricultural Board at Cawnpore in February 1907. The Department will now be organised on the lines laid down in Sir Bamfylde Fuller's minute dated the 16th February 1906, of which a copy* is attached for easy reference. The superior staff at present consists of an Assistant Director of Agriculture and a Fibre Expert. A Superintendent of the Civil Veterinary Department is in training at Belgachia and will join after a few months. An Agricultural Chemist and an Economic Botanist are expected from England next cold weather. Three students have recently been sent by this Government for special training at Poona and Pusa with a view to their ultimate appointment as Agricultural Supervisors. They will go through a five years' course of study. The arrangements for carrying on the work until these students are trained are now under consideration.

II.—Equipment of Agricultural Stations.

The Department has in its direct charge the following Agricultural stations :—

(i) The Central Station at Dacca.
(ii) The Rajshahi station.
(iii) The Rangpur station for tobacco.
(iv) The Jorhat station for sugarcane.
(v) The Upper Shillong Farm and the Shillong Fruit Garden, which are worked as a single concern.
(vi) The Wahjain Tropical Plantation.

A few brief notes regarding the equipment of each of the above stations are given below :—

(i) The Dacca Central Station came into being only a few months ago. The land has just been acquired. It has yet to be fenced in and provided with the necessary buildings. The work of construction has begun and is not expected to be completed before a year ; it may take longer. Roads and paths will have to be made. A considerable portion of the land which will be devoted to experimental work will have to be reclaimed from jungle, levelled and plotted out. The work of reclamation has begun, but the land will not be in a suitable condition for experimental purposes before some two years. The Farm remains to be provided also with working cattle and implements. The Dacca Central Station will be the head-quarters for the Expert Staff of the Department. Buildings are in course of construction for the accommodation of these officers and their subordinate staff. Laboratories are also about to be constructed.

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*Not printed in these Proceedings.

(ii) The Rajshahi station which was established in the latter part of 1904 still remains to be provided with the necessary farm buildings. Although Government has been in possession of the land since 1904, the ownership of the land has been in an undetermined state, and it has been thought unwise to expend money upon permanent buildings. Steps will now be taken to acquire the land under the Land Acquisition Act and to erect the necessary farm buildings.

(iii) The site of the existing Rangpur station having been pronounced unsuitable for tobacco research by Mr. Sly, it has been decided to open a new tobacco farm at Burirhat, a place five miles from the Rangpur civil stations. It is proposed to make over the existing farm to the Rangpur Agricultural Association which was instrumental in establishing the farm. The site of the new farm has been selected. If funds permit, the site will now be acquired and as much progress as possible will be made in 1907-08 towards erecting buildings and bringing the land under tobacco cultivation. The land is at present fallow.

(iv) The Jorhat station which is a little over a year old remains to be provided with permanent buildings. These will be constructed in the ensuing year.

(v) & (vi) The equipment of these stations is fairly complete. The Inspection Bungalow at Wahjain may need to be rebuilt.

III.—Experimental work at the Agricultural Stations.

No programme of work has yet been prepared for the Dacca Central Station or for the new Tobacco Station at Rangpur. The programmes of the other stations for the year 1907-08 will be practically the same as for the current year. They are reproduced below with a few modifications.

The Rajshahi Agricultural Station.

I.—New Crops—

1. *Potato.*—Nainital and Patna (red skinned round, from Shillong). There is no means of irrigation, but a small area of light loamy soil will be planted to ascertain if potato can be grown without irrigation, as at Rangpur and in Assam Valley generally.

2. *Malancha.*—*Malachra capitata*—a new fibre.

II.— Variety Experiments—

1. Coarse winter rice—
   Hatisal of Assam.
   Common local variety.

2. Fine winter rice—
   Bansmati (Burdwan).
   Dadkani (Dinajpur).
   Kataribhog (Dinajpur).
   Badsabhog (Burdwan).
   Maniki Madhuri (Assam).
   Black Joha (ditto).

3. Autumn rice (Aus)—
   Local variety.
   Central Provinces fine.

4. Sugarcane—
   Local (Khagra or Khari).
   Dacca Gandari (and one or two more kinds).

5. Wheat—
   Local white.
   Local red.
   Mazaffarnagar white.

III.—Manure Experiments—

1. Winter rice (local variety)—
   Try (1) Bonomeal, 6 maunds per acre *versus* no manure.

(2) Green manure with cowpea *versus* no manure.

2. Sugarcane (local variety)—

Try (1) Cowdung, 150 maunds per acre *versus* cowdung *plus* castor cake 24 maunds per acre.

(2) Similar experiments with super 6 maunds per acre and saltpetre 2 maunds per acre *versus* castor cake 24 maunds per acre.

IV.—Seed Selection—

Try (1) Common local coarse variety of winter rice.
(2) Ditto fine ditto.

V.—Jute—

A programme for jute experiments is being drawn up by Mr. Finlow. He will work in co-operation with the officers of the Bengal Government who are experimenting at Burdwan.

VI.—Mulbery—

This is a very important crop in the Rajshahi Division. Experiments will be made in manuring the crop as a substitute for the local custom of banking up with new earth.

The existing Rangpur Agricultural Station.

I.—Tobacco for wrappers—

(1) Sumatra under shade.
(2) Do. without shade.
(3) Between rose of tallgrowing annual plants, such as rahar or castor-oil.

II.—Cigar-leaf tobacco for fillers, with American and selected indigenous varieties.

III.—Cigarette tobacco—

Cavalla, Isabelli, Sari and Scented leaf.

IV.—Ginger—
Local,
Jamaica,
Cochin, and
Calicut.

V.—Potato—improved varieties grown without irrigation.

VI.—Varieties of fine rice.

The Jorhat Agricultural Station.

This farm is to be devoted mainly to experiments in sugarcane. Under the advice of Mr. Sly, the greater part of the land is being cropped with cereals with a view to bring the soil, as far as possible, to a condition of uniform fertility in order to render it fit for comparative experiments. The sugarcane work in the farm will be restricted for a year or two longer to the propagation of indigenous and exotic varieties with a view to the supply of seed-cuttings for future experimental work.

Caravonica cotton and potato are being grown as minor experimental crops. It is proposed to continue their cultivation in the coming year.

The Upper Shillong Farm and the Shillong Fruit Garden.

1. *Potatoes*—

(*a*) Trial of varieties.
(*b*) Trial of Bordeaux mixture as a fungicide.
(*c*) Trial of manures. It is proposed only to try green-manuring.
(*d*) Distribution of seed potatoes of the varieties that have been found successful.

2. *Introduction of European fruits and fruits of the semi-temperate climate.*—These include apple, pear, cherry, plum, apricot, peach, grape, gooseberry, raspberry, currant, strawberry, fig, walnut, almond, loquat, treetometo cherimoyer and mountain pappaya.

3. *Distribution of trees and seeds* of such new fruits and vegetables as have proved successful. These include Australian pear, strawberry, fig, Spanish chestnut, rhubarb, asparagus and a large fruited variety of squash (*Sechium edule*).

4. *Trial of new crops.*—Three varieties of American sweet potatoes (New Jersey, Virginia, Nonsimmond) and Jerusalem artichoke.

5. *Preservation of fodder in silos.*—Efforts are being made to introduce silo-making among the Khasias.

6. *Silk.*—The cultivation of mulberry will be continued, as well as experiments in silk-worms.

7. *Cattle-breeding.*—The dairy farm will be continued, and efforts will be made to improve local breeds of cattle, by the distribution of stock from the farm.

The Whajain Tropical Plantation.

The plantation is used as the trial ground for various species of tropical spices, drugs and fruits. These are as follows:—

A. Spices.—Cinnamon.
Lessor Cardamom.
Greater ,,
Nutmeg.
Clove.

B. Drugs.—Cocoa.
Coffee.
Camphor.

C. Fruits.—Oranges and other citrus fruit.
Kew and Ceylon Pineapple.
Bangaloro pappaya.
Grafted Mango.
,, Litchi.
Sapota.
Banana.
Breadfruit.
Rambutan.
Soursop.
Cherimoyer.

D. Lemongrass for essential oil.

IV.—Experimental Work outside the Agricultural Stations.

The programme of work outside the Agricultural Stations of the Department includes measures taken to encourage the spread of jute cultivation in Upper Assam, experiments in wheat cultivation in the Assam Valley, distribution of seeds and manures to private persons and Government officials, the maintenance of the Sericultural School at Rajshahi and the introduction of improved hand-looms for the benefit of the weaving community. Numerous experiments are also being made in Government and Wards' Estates throughout the Province. The "Model Farm" maintained by the Khas Mahal Department at Chittagong will not be altogether abandoned as was at one time feared. The local officers proposed to lease it to a gentleman who will continue to conduct agricultural expriments. There are several private experimental farms in the Province which are doing creditable work—particularly the farm of Babu Brojendra Kishore Acharjya at Gouripur in Mymensingh, the farm of Babu Baikuntha Kumar Nandi at Itakhola in Sylhet, and the farm of Babu Man Gobind De Chowdhury at Krishnapur in Cachar. The two last-named farms are making very hopeful experiments in tree cotton. The Department will help these private farms by inspection, advice and facilities for obtaining seed and manure.

V.—Special Work of the Fibre Expert.

Mr. Finlow's present head-quaters are at Pusa, but when his house has been constructed, he will come to Dacca. His laboratory will not be ready as soon as his house, but a temporary arrangement will be made until the regular laboratory is complete. Mr. Finlow has been making elaborate experiments on the absorption of moisture by jute. As the Government of this Province has recently decided not to embark on legislation regarding wet jute, it is probable that Mr. Finlow's experiments on this subject may now be abandoned. This will set Mr. Finlow's laboratory free for experiments which he desires to conduct regarding the chemical composition of jute fibre under various conditions. In out-door work Mr. Finlow will continue "selective" experiments in jute and will also make experiments regarding the best conditions under which retting can be conducted. He will also investigate fibre plants other than jute. At Rajshahi Farm he will make manure and other experiments in the cultivation of jute. In this work he will, as already *pointed out*, co-operate with the Bengal officers who are making similar experiments at Burdwan. Mr. Finlow will give help and advice to those who are extending jute cultivation in new tracts, particularly in the Assam portion of the Province. I may mention here that the authorities of the Assam-Bengal Railway desire to conduct jute experiments through their station masters all along the line. The Department will give them help in the matter of seed and instructions, and Mr. Finlow will tour along the line to give professional advice. This is a hopeful departure and the process may be extended to crops other than jute. Passengers waiting at railway stations have plenty of time to study experimental cultivation in plots of railway land adjoining the station.

VI.—Organisation of the Provincial Veterinary Department.

A scheme for the organisation of the Department has been submitted to the Government of India by this Government. Under this scheme the ultimate strength of the Veterinary Establishment is to consist of a Superintendent, who would be a member of the Imperial Veterinary Service, two Deputy Superintendents, eight Inspectors, and 120 Assistants. Each of the 57 sub-divisions in the plains districts is to be provided with one Stationary and one Itinerating Veterinary Assistant. There will be besides six Veterinary Assistants for employment in Hill districts and on special work. It is thought that the immediate needs of the province can be met by appointing three Inspectors and 46 Assistants in addition to one Inspector and 14 Assistants now employed. The Province will continue to depend on the Belgachia College in Bengal for the training of its subordinate Veterinary staff, and the Local Government will contribute a certain sum annually towards the up-keep of the College.

Mr. Harris, the newly appointed Superintendent of the Department, will join in April and the Department will be gradually organised as qualified Veterinary Assistants are forthcoming.

There has been a virulent epidemic of cattle disease in the Surma Valley, and it is proposed to take special steps to deal with it through non-official agency pending the organisation of the Department.

Mysore.

The work proposed to be done by the Mysore Department of Agriculture is:—

(*a*) To continue the study of soil moisture, especially with a view of determining in how far the capillary action of the Mysore soil is able to lift water to the surface and what effect cultivation and growing crops have on soil moisture.

(*b*) To make preliminary pot-culture experiments with potash fertilizers, especially noting their effect on the mechanical condition of Mysore soils.

(*c*) To continue pot-culture experiments with bone-meal with a view of getting some information regarding the factors which affect its availability.

(*d*) To continue the standardization of the plots on the Experimental Farm at Hebbal and try to reduce the experimental error due to accidental differences other than soil. This error amounted in one case to 27½ per cent and on the average to about 8 per cent. of the total yield of the crop. The differences in crop due to differences in the soil of adjoining plots has amounted to 100 per cent. in one instance.

(*e*) The establishment of a Mycological and Entomological Laboratory and, as far as circumstances will permit, a preliminary study of one or more of the plant diseases or insect pests of Mysore.

(*f*) Continuation of the routine work of the Department, such as the analyses of fertilizers, soils, a series of coffee samples, "famine foods," etc. Also, if the time permits, a series of tests to study the absorption of plant food by Mysore soils out of solutions percolating through them, especially phosphates.

Baroda.

I.—Experimental work at the Baroda Model Farm to be continued on the following points:—

(1) Sowing Egyptian cotton in March and April.
(2) Manuring of cotton.
(3) Artificial manures in sugarcane and tobacco.
(4) Preservation of sugarcane seed and planting of stool.
(5) Groundnut in dry rotation.
(6) Cheese-making and utilization of skim milk.

II.—Seed selection and distribution of ordinary crops

III.—Introduction of groundnut.

Entomology:—

Study and combating of cotton pests.

Investigation of wheat and rape-seed pest.

Education:—

Introduction of revised course in the school of Agriculture.

Travelling Instructors:—Increasing the number of instructors as men become available.

Demonstration Farms.—Developing the demonstration farms in Kadi and Amreli.

APPENDIX E.

PAPERS ON COMMERCIAL FERTILIZERS IN INDIA.

MEMORANDUM ON THE USE OF, AND TRADE IN, ARTIFICIAL MANURES IN BENGAL, EASTERN BENGAL AND ASSAM, BY HAROLD H. MANN, D.Sc., SCIENTIFIC OFFICER TO THE INDIAN TEA ASSOCIATION.

In the inquiry which was discussed and proposed at the last meeting of the Board of Agriculture relative to the question of the advisability of introducing a system of control over the sale of commercial fertilizers in India, I was asked to undertake to find out the present conditions of the manufacture and trade in Bengal and Eastern Bengal and Assam. At an early stage of the investigation Mr. Coventry was kind enough to tell me that he would collect such data as related to Behar and the indigo districts and this limited the field which my inquiries have to cover.

It was suggested that the class of substances which should be included in the scope of the inquiry should be limited to the following :—

1. Imported fertilizers, such as superphosphates, Chili saltpetre, sulphate of ammonia and the like.
2. All mixed fertilizers.
3. Ground phosphates of every kind.
4. Ground bone and bone char.
5. Guano.
6. Milled or ground oilcake.
7. Blood manure.
8. Milled fish.
9. Refined Indian saltpetre.

To these I have ventured to add 10, sulphur, as although this is not properly a fertilizer, yet its use for agricultural purposes has enormously increased in recent years, and it stands on much the same basis as to possible adulteration as the others.

Before proceeding to consider such of the above manures as have, or are likely to have, any importance, it may be well to eliminate the remainder. I can find no trace of any import of, or commerce in, two of the above substances, namely, guano and blood manure. It is extremely unlikely that either of these will be imported or used in the future, and in view of this fact nothing more need be said about them.

Of the remainder, some seem to be entirely imported as such, and some to be partly imported and partly manufactured from the raw material here, and some to be entirely country products. To the first of these classes belong Chili saltpetre, ground phosphates, dissolved bones and sulphur, to the second belong superphosphates, sulphate of ammonia and the various mixed fertilizers, while the remainder are entirely made in India itself so far as I can make out. It may be well to consider these various classes of material in this order.

Chili saltpetre or nitrate of soda is imported into Bengal for agricultural purposes in exceedingly small quantities. In the year 1905-06, I can only trace the import of 20 cwts. of this material valued at the port at ₹226. I can find no trace of any having been sold, except by one firm, who in the last three years inform me that they have disposed of only 5 cwts., 5 cwts. and 34 cwts., respectively, practically the whole of which has been used for experimenta purposes on Government or other experimental stations. Though there is evidence to show that the action of nitrate of soda is not precisely the same as that of saltpetre, yet, in view of the large amount of the latter available here, it is not likely that a large market for nitrate of soda is likely to arise.

Ground phosphates are in a similar position, except for the fact that they furnish the raw material for the manufacture of superphosphate. Considered as manures in themselves, their present use is purely an experimental one, and so far as I can make out only about ten tons were sold for this purpose during

last year. I am informed that the whole of this is of Indian origin, presumably from Trichinopoly, but my informants give no details.

Dissolved bones also prove, rather to my surprise, to be entirely imported as such. The total demand seems to be for 'Indigo factories and Government experimental farms' and, including a small quantity for tea estates, only amounts to a very few tons, the largest dealers only stating a sale of 3 tons during the last year.

Of these three materials, as a result of all the information I have collected, there seems a general impression that there is no room for nitrate of soda, that ground phosphates are only to be considered as a raw material for superphosphate manufacture, and that no extended use of dissolved bones is likely to take place until they can be manufactured locally, which involves cheap sulphuric acid. Only, therefore, the third of these is really within the scope of our investigation, and its extended use is so distant and so problematical that it can hardly be considered a question of practical politics.

Included in this class, however, is the very important material sulphur, whose import has been increasing by enormous strides in the last five years, chiefly for blight destruction (red spider, pink mite, thread blight, etc.) on tea estates. During the last few years the amount imported into Bengal has been as follows :—

	Amount. Cwts.	Value. ₹
1901-02	22,314	1,35,351
1902-03	28,318	1,49,226
1903-04	34,309	1,73,441
1904-05	40,974	1,90,977
1905-06	48,536	2,39,624

Most of this comes from Sicily, but I had a sample sent to me some time ago as from Japan which was available in Calcutta at ₹83 per ton, whereas the price of the Sicilian sulphur is nearer ₹100 per ton. I have had a very large number of samples of sulphur through my hands, and they have been, every one, exceedingly pure, and preference between several samples has practically always to be made as a result of determination of *fineness*, the finest being naturally the best for blight destruction. Most of that used is finely ground sulphur, and not in the form of 'flowers,' but the grinding is usually done before importation. This material is rarely purchased through local dealers, usually it is obtained either from the importers or a large Calcutta firm.

Turning to the second class of fertilizers, namely, those partly imported as such and partly manufactured from the raw material in India, I have found very great difficulty in ascertaining the relative amounts imported and manufactured. If we take the whole of the material classified as 'Manure' by the Customs at Calcutta as belonging to this class, the total amount received in 1905-06 amounted to a value of ₹4,146 only, of which ₹1,718 belong to one single consignment of 'manure for sugar.' This shows the very small extent of the trade. I know three importing houses in Calcutta who have taken up agencies for European manure firms in the last five or six years; of these, one has abandoned the trade altogether, another supplies its few orders locally from another firm, and a third has barely commenced. It may practically be said that Messrs. D. Waldie & Co., of Konnagar, are the only firm in Bengal proper (excluding Behar) who do a serious business in directly imported artificial manures.

The business done in commercial manures of the kinds specified (superphosphates, sulphate of ammonia, mixed fertilizers) which are manufactured or made up from raw materials in India is somewhat greater. Once again with regard to the first and third of these, Messrs. D. Waldie & Co. are, so far as I can tell, the only manufacturers in the districts now under discussion.

As regards superphosphate, the whole amount locally made is only about 40 tons per annum, and shows no tendency to increase at present. The likelihood of future increase under present conditions is not great at least in the tea areas. Much would, probably, be used if the price were reasonable, but it costs in Calcutta ₹60 to ₹65 per ton, or, say, ₹80 per ton or thereabouts on a tea estate. This is at least two-and-a-half times as much as in England, and though the benefit derived, even in tea culture, is quite considerable, yet it will certainly (judged by my results at Heeleaka) barely pay the cost of

application. The use of larger quantities of superphosphates is therefore intimately connected with a reduction in the price of sulphuric acid. Till this takes place, it will only in rare cases pay for application; if it is once effected, it is quite likely that a slow increase in the demand would arise, but it would be very slow.

The distribution, such as it is, is entirely in the hands of large firms in Calcutta. No local dealer in my districts deals in it. The superphosphate is made and ground by machinery entirely. I have not succeeded in getting to know whether it is prepared chiefly from ground mineral phosphates or from bone ash. Judging by samples which have come into my hands, I should judge it is principally the former. In any case I am informed that such ground phosphates as are used for preparing it are indigenous.

Mixed manures are used in exceedingly small quantities and are of the usual character. "Special tea manure," "special potato manure," and so on are on the market, but the demand is practically nil. I am informed that tea-gardens are the principal customers for these, and the demand from them is certainly not more than, say, ten tons per annum and the trade shows no tendency to increase. They are principally composed of fine ground bones, with superphosphate, and sulphate of ammonia so far as I can tell.

Sulphate of ammonia shows signs of increasing demand in a greater measure than these other materials. It is not, however, for tea, for jute, or for country crops, but almost entirely for sugar and indigo. I may say that *none* is used in the tea industry. Up to quite recently this has also been a monopoly in Bengal of one firm, and they inform me that their sales have hitherto amounted to under 100 tons per annum.

Now it seems that the manufacture is to be taken up on an extended scale in the coal districts, and no doubt if it can be produced at a reasonable rate, it will be quickly in demand for the abovementioned purposes. Among the purely artificial manures, there is more immediate prospect of the extended use of this material than of any other. It is not likely, however, to extend into native agriculture for a long time, and meanwhile it will be bought in large quantities from the makers.

We have now dealt with all those of the manures about which inquiry was made which are imported either in the form of raw material, or as ready-made fertilizers. There remain those produced in the country, which are really the only ones extensively used. These are—

(1) Oilcake.
(2) Refined Indian saltpetre.
(3) Bones, bone char, and bone ash.
(5) Fish.

Of these, the use of the last-named is exceedingly small. One of my informants states that "Fish manure has come to be used in recent years in small quantities by tobacco growers in parts of the Rungpur District. This manure is not imported as such, but is simply the dry dusty refuse that has been left over from dried fish, which is extensively consumed in Eastern Bengal." I was approached myself some time ago by a Chittagong firm as to what demand there would be from the tea industry if they set up a mill at that part to prepare fish manure, but nothing came of it. Fish may be at present used near the coast or near the rivers, but there is no prospect of any production of fish manure on a large scale.*

There are quite a number of bone-crushing mills in Bengal, but nearly all their production is exported. The following are, I believe, all the bone-crushing firms in the Provinces:—

(*a*) *Agricultural Phosphate Company, Limited.*—Agents, Messrs. Mackillican & Co., Calcutta, Works at Ultadanga. These mills crush bones only and *steam* so far as is necessary for export purposes to New Zealand and elsewhere.
(*b*) *Bally Khal Bone Mills.*
(*c*) *Bengal Bone Mills.*—Works at Balliaghata.
(*d*) *Chingrihatta Bone Mill.*—Works at Chingrihatta, Calcutta.

* Since writing the above, I have been approached by a Calcutta firm, who offer me five hundred ton per annum of 'animal meal' (chiefly fish, I think) containing 7 to 8 per cent. nitrogen and 13 per cent. phosphoric acid at R105 per ton.

(e) *Ganges Valley Bone Mill Company.*—A Glasgow firm. Agents, Messrs. Graham & Co. Mills at Uttarpara, Hooghly.

(f) *Standard Bone Mills.*—Chingrihatta, Calcutta.

In addition to these, there has been a gradually increasing number of tea-gardens who put up their own bone disintegrator, collect bones from the district, crush them, and apply to their own land. The machine used for this propose is the so-called 'Devil Disintegrator.' One of the planters in Assam, who has the installation longest, writes me relative to his bone supply as follows: 'I pay Rl-4-0 per maund (80 lb.) delivered at the factory, and it costs me, including labour, Rl-12-9 ready to put on the land. I could now, I think, get the bones for Rl or Rl-2-0. I did not care to reduce the price as I was afraid of frightening the collectors away, as I had a good deal of difficulty in getting them to bring any at first.' Another local planter quite close to the above only pays Rl per maund. The manager of a large tea estate in the Duars, where bones have been crushed for a long time, writes me that the local price of bones is Rl per maund, but most are collected on their own property and in their own bazaars. One planter takes, or did take, all the bones, I believe, from the Darjeeling bazaar.

This is not, however, commercial production. And in considering the possibility of an extended trade in bone meal to the tea districts, it must not be forgotten that these very districts are the sources from which the bone mills themselves draw a large amount of their supply of raw material. Considering that every tea estate has steam or equivalent power on the spot, and bones are to be had locally, it is not at all likely that there will be a large trade in ground bones or bone meal from Calcutta. In fact, the actual use of bought bone meal is getting less rather than increasing.

Apart from the tea industry, bones are not used at all in the area I am considering. Mr. Basu (Assistant Director of Agriculture for the new Province) writes me—"The use of bones is absolutely unknown to the native agriculturist in this Province." This appears also true for Bengal proper. The results of the experiments with bone meal and saltpetre for paddy have, however, been so striking that it is just possible that their use may take a very gradual extension for this crop. It would be absurd, however, to suppose that this can take place with anything but the greatest slowness. For sugar and indigo, bone meal will not take great extension, and, as before stated, the conversion into dissolved bones, or bone ash superphosphate, depends on the presence of cheap sulphuric acid. Bone char is produced in some quantity, but I have only once heard of its proposed use in these districts for manure, and this was for tea

Summing up all the information available with regard to bones, it may be said that bones are not likely to become a favourite manure for tea, and if they do, it is most probable they will be ground locally on the gardens which use them. For sugar and indigo little is used, and little is likely to be used. For country crops, no bones are used at present, though there is a possibility that, following the experiments at Burdwan, etc., they may take a very gradual extension for paddy. The use of dissolved bones and bone ash superphosphate must await, at least, cheap sulphuric acid.

It may be interesting to give the actual export of bones from Bengal (including Assam) for the last five years, which will indicate the amount available. The largest purchaser is New Zealand, then the United Kingdom, and then Japan.

Year	Quantity	Value.
	Tons.	R
1900-01	19,645	7,89,187
1901-02	15,212	9,74,985
1902-03	23,081	12,74,712
1903-04	20,220	15,51,940
1904-05	24,141	13,21,990
1905-06	27,056	15,34,037

During the past year the value of bone meal in Calcutta has been remarkably constant, and it has been quoted with a guarantee of 4½ per cent. ammonia and 52 per cent. tribasic phosphate of lime at R59-8-0 per ton in the last three months of 1905 to R61-0-0 per ton from July to September 1906. It has, however, risen to R65 per ton at the end of the year.

I may say that in the bones and bone meal which have come before me I have found no trace of adulteration or of selling boiled bones as genuine bone meal.

It remains now to discuss the production and use of refined saltpetre and oilcakes, probably the only two artificial manures of present importance and of probable importance in the near future. First, as to refined saltpetre. An enormous number of data on the manufacture and composition of Indian saltpetre have been recently brought together by Mr. D. Hooper (Agricultural Ledger, 1905, No. 3). According to him the principal centres of saltpetre refining are Farukhabad, Cawnpore, Sitapur and Shahjahanpur in the United Provinces, Hissar, Ferozpore and Montgomery in the Punjab and Saran, Muzaffarpur and Darbhanga in Behar. In Calcutta I may say that in the trade the best class of "refined" saltpetre is almost invariably spoken of as "Farukhabad refined." There are, however, quite a number of small refineries at Narealdanga near Calcutta, but the price they obtain is never equal to that for the so-called Farukhabad refined saltpetre.

In Calcutta saltpetre is usually sold on a basis of 5 per cent., 10 per cent, or 15 per cent "refraction," that is to say, the impurities are guaranteed to amount to not more than 5, 10 or 15 per cent., as the case may be. In my experience the samples so sold rarely reach the guarantee if moisture be included as an impurity, as it always is by the trade. But in our climate this item is very uncertain and I have found the amount vary from ·47 to 2·85 per cent. The following are ordinary commercial analyses done by me during the past year of samples bought in the Calcutta bazaar :—

	"Farukhabad refined saltpetre."					Calcutta refined
	1	2	3	4	5	6
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent	Per cent.
Moisture	93	2·43	2·40	2·50	2·85	·47
Common salt	1·11	2·42	2·47	3·18	1·63	7·82
Sulphate of potash	·19	·88	·95	1·42	·17	81
Insoluble matter	...	...	...	07	...	·12
Nitrate of potash	97·77	91·27	94·18	92·53	95·35	90·75
Total	100·00	100·00	100·00	100·00	100·00	100·00
Refraction	2·23	5·73	5·82	7·47	4·65	9·25

These were actual representative samples drawn from lots under sale to tea-gardens, all sold on a '5 per cent. refraction' guarantee, but it is fair to say that in every case the contract for sale provided for an allowance being made if the refraction was in excess of the guarantee. For instance, the allowance on the Calcutta sample above would be 11 annas per maund, reducing the price in December 1905 from R8-10-0 to R7-15-0 per maund.

Dr. Leather was good enough to make for me two more complete analyses of samples bought equally in the course of trade and under the same guarantee. The results were as follows :—

	A.	B.
Potassium nitrate	93·13	92·97
Potassium chloride	1·81	2·15
Sodium chloride	1·25	·59
Sodium sulphate	·89	·70
Moisture	2·08	2·89
Insoluble matter, etc.	·85	·70
	100·00	100·00
Nitrogen	12·92	12·90
Potash	44·52	44·54
Refraction	6·88	7·08

There does not seem to have been much difficulty in regard to adulteration hitherto, and a buyer of any considerable quantity has never had any trouble in getting a guarantee from the traders in the bazaar. And any large adulteration is hardly likely in the future. The only probable addition would be common salt, and this would make the saltpetre quickly so wet, owing to the hygroscopic character of the salt, that it would very quickly be detected in the Indian climate.

By far the largest amount of saltpetre is exported. Mr. Hooper gives the average actual export from India in the ten years from 1893—1903 as follows:—

	₹	a.	p.	
1893-94—1897-98—408,585 cwts. . .	At a price of	11	0	8 per cwt.
1898-99—1902-03—374,810 cwts. . .	At a price of	9	15	0 per cwt.

Since 1903 the amount exported from Calcutta to foreign countries has been as follows:—

	₹	a	p.
1903-04—386,412 cwts.	At a price of	10	6	0
1904-05—343,312 cwts.	At a price of	10	6	0
1905-06—332,356 cwts.	At a price of	11	7	0

Hardly any saltpetre is expected from other Indian parts. Of the total quantity shipped in Calcutta in 1905-06, 3,476 cwts. went to Indian ports, the remainder going abroad. The relative quantity from the different sources of supply sent to Calcutta was as follows in the last three years:—

	1903-04. cwts.	1904-05. cwts.
Behar and other Bengal sources	324,271	259,262
United Provinces	131,011	114,552
Punjab	102,711	81,017
Other parts of India	2,425	1,658

The small use made of material in the area with which we are dealing is shown by the minute amount sent into other parts of Bengal than Calcutta, which was as follows:—

1903-04	. 11,828 cwts.
1904-05	. 16,592 cwts.

The amount utilised in Assam (where none is made) is exceedingly small also as follows:—

	Mds.	Worth. ₹
1900-01	407	3,063
1901-02	203	1,461
1902-03	378	2,606
1903-04	367	2,580
1904-05	418	2,954

Of course it is by no means certain that these amounts even are entirely used for manurial purposes, but this represents the maximum quantity.

It has been employed more or less experimentally for tea for some years, but never extensively. One large Calcutta firm sent to Assam during the past season no less than 960 cwts. to their estates, but this is quite exceptional, and so far tea-planters have fought very shy of these highly soluble manures for their crop. I am not aware of its being extensively used for indigo, but am informed that considerable quantities have been supplied and used on estates under the Court of Wards. In ordinary agriculture, crude saltpetre is occasionally used, but refined hardly ever in the area I am dealing with.

The prospects of its being used on a larger scale in the future depend very largely on the success of the experiments and demonstrations of the agricultural departments concerned. It is certain that it will not push *itself* as a manure, for the high cost and the temporary character of the effect would prevent in any case the rapid extension of its use. The agricultural department of Bengal seems, however, to have shown that combined with bones it forms the most profitable manure known for paddy, and some of the demonstrations of last year were markedly successful. But the adoption of such a method of manuring will be very slow.

The price of saltpetre in the Calcutta market on a 5 per cent. refraction basis varies, as has already been said, with the source of the material. During

the year from October 1905 to October 1906 Calcutta refined (5 per cent. refraction) has varied from a weekly average of R7-9-6 per factory maund, in January 1906 to a weekly average of R8-11-0 in November 1905. These amounts are equivalent, respectively (the factory maund being 74¾lb), to R227-8-0 and R260-10-0 per ton. At the same time Farukhabad refined saltpetre (5 per cent. refraction) was selling (weekly average) from R8-2-0 per factory maund in March to R10-0-0 per factory maund in July. These prices correspond to R243-0-0 per ton in March and R300-0-0 per ton in July. To give an idea of the value of the lower qualities, I may say that in August 1906, when 5 per cent. refraction (Calcutta refined) was selling at R8-6-0 per factory maund, 10 per cent. refraction obtained R7-10-0 and 15 per cent. refraction R7-2-0 for the same quantity.

As regards tea, it may be said that, while there is abundance of oilcake to be had at anything like the present price, the use of saltpetre is quite unlikely to take any very great extension. The cost is approximately, for 5 per cent. refraction, say, R270-0-0 per ton in Assam. Taking the potash as being ⅓ the value per unit of the nitrogen, this would give a value of nitrogen per ton unit of R10-0-0.

Now oilcake (rape cake) containing 4½ per cent. of nitrogen, 3 per cent. of phosphoric acid and 83 per cent. of organic matter has been lately costing R1-6-0 to R1-8-0 per maund of 80lb in Assam, or R37 to R40 per ton approximately. Reckoning phosphoric acid as ⅓ and organic matter as $\frac{1}{200}$s the value of nitrogen, the value of the last named per ton unit is R6-12-0, or, in other words, the oilcake is very much cheaper. If bazaar castor cake has to be bought from Calcutta, costing, say, R3-8-0 per maund, or R94 per ton, the value per ton unit of nitrogen is R11-8-0, or higher than that in saltpetre. This is dearer than saltpetre, but the price is an unheard of one until the present season. Inasmuch as we want a fairly permanent manure in tea culture, as the potash is of only doubtful value, and as our soils are usually deficient in organic matter, it will be seen that one cannot recommend saltpetre as against oilcake at present, unless in some special case, and it will probably be some time before the price will justify its extended use.

Oilcake is the best and by far the most important of the materials in North-East India with which I have to deal. At present it is the *only* one of any real importance, and its use is no new thing.

The seeds chiefly used for making it are castor, mustard and rape, in their various varieties, til and linseed, chiefly the two first mentioned. Groundnut cake hardly occurs in Bengal and Eastern Bengal.

By far the largest amount is still made in local village mills, and with their produce the present inquiry has nothing to do. I may say, however, that the only case of serious adulteration which has come before me was in such cake, bought locally near Jorhat (Assam), which contained 26 per cent. of sand. This case came before the District Court as an ordinary civil suit, and adequate damages were given.

But there are a certain and increasing number of larger mills, chiefly in Calcutta and neighbourhood. Some of these are large establishments like the British Indian Oil Mills, of Garden Reach, Calcutta, which only work castor seed, or the Gourpore Oil Mills, which only work linseed, I believe. Most of the Calcutta oil mills are of a very different type. I quote notes made of visits to two of them.

1. Mill at Halsibagan Road, Shambazar, Calcutta, belonging to Babu Dinanath Mookerjee. This concern is a good one, and the machinery and plant when imported cost nearly half a lakh of rupees. But the oil is not the main business of the mill. It produces a large quantity of flour, which is sold and delivered to large firms. The oil portion of the mill is in a separate building, and six crushers were at work. Only mustard seed is used. Some *Carthamus tinctorius* seeds were noticed about, but they were said to have come mixed with the mustard seed. The amount turned out was said to vary, but they sometimes produce 5,000 to 6,000 maunds per annum, and could make as much as 10,000 maunds. The cake is chiefly sold to cattle-keepers in small quantities of a few maunds, and also to merchants, who resell for cattle-feeding. At least half the produce of the mill is sold for cattle food.

2. The second mill visited was in Goabagan, Calcutta, and is a much smaller one than the last, and is a very primitive with old fashioned machinery. Castor seed is crushed here, both the large and small-seeded variety being used. The mill probably turns out 1,000 maunds per annum. The oilcake is disposed of through the agency of brokers, said to be principally for export, but the manager has no direct dealings with buyers of oilcake.

These are, probably, two fairly typical Calcutta native mills.

In the districts mills are increasing fast in number. Three years ago one was started in Gauhati for mustard and has been very successful, and now quite large places are being founded at Chandpur, at Parbatipur and at Chaparmukh (Nowgong, Assam). There is also a fair sized mill at Phulchari in Rungpur. In addition quite a number of tea estates are putting up installations for their own use, *e.g.*, the Jorehaut Tea Company, the Scottish Assam Tea Company, the Loongsoong Tea Estate, etc., etc. The Gauhati mill is the largest of these and can turn out 200 maunds of oilcake daily, or, say, 60,000 maunds (between 2,000 and 3,000 tons) per annum. The Chaparmukh mill will make 100 maunds daily. The Assam and Bengal jails produce a certain small quantity.

Any attempt to judge the proportion of the total oilcake supply supplied by mills worked by machinery must be little more than a guess; the amount is constantly increasing, but there is no likelihood of machinery replacing bullock power in the near future. On the whole the cake made by bullock power is remarkably well pressed. Certainly as yet the quantity of oilcake made by machinery is not more than one-fourth of the total, probably much less.

Hitherto there has been an enormous foreign trade in oilcakes. Linseed cake stands apart, being exported chiefly in milled form for feeding. During 1905-06 (as extracted from the daily Customs entries) there were exported from Calcutta to foreign countries 22,549 cwts. of a nominal value of ₹23,595, though the real value was undoubtedly much higher than this. To Indian ports 524 cwts. were sent of a value of ₹3,348. This hardly interests the present question however, for linseed cake, milled or otherwise, is not used for manuring as such at all.

Of other oilcakes, the total export was 358,538 cwts., of which 21,442 cwts. only were re-imported at other Indian ports. Of the total quantity for foreign ports, 18,820 cwts. were declared as for manure.

I have not been able to obtain statistics of the production or places to which the cakes are sent from most of the mills, but can give it for some of them. The British Indian Oil Mills have been kind enough to supply figures for 1904 and 1905 of their 'castor meal' as follows:—

	Exported.	Tea-gardens.	Country and local consumption	Total.
	Mds.	Mds.	Mds.	Mds.
1904 . . .	21,530	21,071	2,470	45,071
1905 . . .	7,485	45,316	11,298	64,099

They informed me also that their whole supply in 1906 to the end of August (5,000 maunds a month) were ordered from Japan. Of the oilcake exported as for manure the United Kingdom, China and Japan were the only large importers.

The production of Assam oil mills is entirely absorbed locally, and the same may be said of the other new mills run by machinery.

The details I have been able to ascertain regarding the crops for which oilcake is used are as follows:—

Tea.—The use of oilcake for tea in any large quantity is quite a recent development, but is increasing by enormous strides. *One* firm of agents last year sent up to their estates 4,050 maunds of cake and meal in 1905-06, and this is by no means the largest amount. It may, in fact, be said that almost every up-to-date concern in the Assam Valley either is regularly using oilcake now, or is experimenting with it. It has penetrated not to quite the same extent into the Surma Valley, and still less into the Duars and Darjeeling, but

is becoming more used in each of these districts. As a rule, hitherto, it has been applied to tea at the rate of 10 to 15 maunds per acre, but there is a tendency now to apply less on each occasion and repeat the dose more often.

Sugarcane—(information given by Messrs. N. G. and D. N Mukerji) is regularly manured with oilcake, bought for the purpose, castor cake being usually much preferred. Twenty maunds per acre is the average amount applied, but even thirty maunds are bought and used for the purpose. In the Assam Valley I am told that practically no oilcake is used. Mr. Basu writes 'the Assamese raiyats may be said to be still ignorant of the use of oilcake as a manure.' Hence sugarcane seems chiefly to be looked upon as a homestead or virgin land crop and is usually poor.

Potatoes are manured commonly in Bengal and Eastern Bengal, but not in the Assam Valley, with oilcake at about the rate of 25 to 30 maunds per acre. I do not know whether oilcake is used for potatoes in the Khasi Hills.

Rice.—Oilcake is occasionally used for autumn rice in Bengal, at the rate of about 5 maunds per acre.

Tobacco.—Rape cake 'is very largely used by tobacco growers in Rungpur, the rate of application being 2 to 3 maunds per *bigha* ($\frac{1}{3}$ acre) ' (Basu).

Pán (betel leaf) is manured with small quantities of oilcake in Eastern Bengal, and, I believe, all over Lower Bengal.

Ginger is also manured to some extent in Rungpur with oilcake (chiefly rape or mustard), and it is one of the staples of that district.

The oilcakes principally used, as I have said, are mustard (or rape) and castor, and, except for one sample of 'moula' or 'radish' cake, no others have passed through my hands.

Mustard cake.—The following are samples which I have examined, all locally crushed :—

	Mustard cake.				
	One year old, North Sylhet.	New, North Sylhet	Dibrugarh.	Bishnauth.	Nowgong.
Moisture	8·87	8·14	8·44	9·04	19·33
Organic matter . . .	83·84	85·04	82·92	80·90	72·89
Lime, phosphoric acid and alkalies, etc. . . .	6·52	5·70	6·50	6·67	6·98
Sand	·77	1·12	1·84	3·39	1·30
Total . .	100·00	100·00	100·00	100·00	100·00
Nitrogen . . .	5·48	5·64	5·17	4·61	4·78

As will be seen, these are all 'good' samples and, except for the Nowgong sample being wet, there is no sign whatever of adulteration. The price is rapidly going up. In 1900 large quantities could be bought in the Assam Valley for 14 annas a maund, now it is difficult to get it at ₹1-6-0. The demand is so great at present that I doubt whether even mills like those at Gauhati would bother to sell on a guarantee, and my last year's advice to planters was to be satisfied if they get it at ₹1-6-0 to ₹1-7-0 per maund (80 lb), reckoning it at $4\frac{1}{2}$ per cent. nitrogen, delivered on the station or ghat. It is probable that during the present year the price will be higher than this. The local material is all *bought from the traders in the bazaar, who finance the cultivators who grow* the crop. The Gauhati and Chaparmukh mills dispose of their produce direct to planters, none going into ordinary agriculture. I have no means of knowing how the produce of the Phulchari and Parbatipur mills reaches the cultivators, but it is almost certain that it is through bazaar traders.

Mustard cake in the Calcutta bazaar has risen in price much during the past year, but not to so great an extent as castor cake, and it is at present

distinctly of better value than the latter. The Calcutta prices for the last year have been as follows:—

	℞ a. p.	℞ a. p.	
October to December 1905	1 1 0	to 1 10 0	per Bengal maund.
January to March 1906	1 5 0	„ 1 11 0	„ „ „
April to June 1906	1 7 6	„ 2 8 0	„ „ „
July to September 1906	1 7 0	„ 1 11 0	„ „ „

Castor cake.—There are two distinct qualities of castor cake on the market, both of which seem to be pure, but of entirely different value. One of these contains barely 4 to 4½ per cent. of nitrogen, and the other 5¾ to 6½ per cent. Curiously enough it is the bazaar castor cake which is high, and that produced by the British Indian Oil Mills which is poor. The latter firm are usually quite ready to guarantee 4¼ to 4½ per cent. nitrogen, but not more. No guarantee is, of course, obtainable in the bazaar. The prices have in the last three years almost exactly been proportionable to the nitrogen content. Thus, when the bazaar cake was ℞1-14-0 to ℞2 per Bengal maund (82⅔lb), the oil mills were selling their cake at ℞1-5-0 to ℞1-6-0. The former means 5·3 annas per maund unit of nitrogen, and the latter 5 annas, counting all the value of the cake as nitrogen.

During the last few years, and the present year especially, the price of castor cake has been going up, and during 1905-06 the rise has been almost continual. The prices on the Calcutta market of the bazaar cake in the last year have been as follows:—

	℞ a. p	℞ a p.	
October 1905	2 0 0	to 2 4 0	per Bengal maund.
November „	2 0 0	„ 3 0 0	„ „ „
December „	2 0 0	„ 2 13 0	„ „ „
January 1906	1 11 0	„ 2 2 0	„ „ „
February „	2 0 0	„ 2 4 0	„ „ „
March „	1 14 0	„ 2 2 0	„ „ „
April „	2 0 0	„ 2 6 0	„ „ „
May „	1 14 0	„ 2 6 0	„ „ „
June „	2 2 6	„ 2 9 0	„ „ „
July „	2 5 0	„ 2 10 0	„ „ „
August „	2 5 0	„ 2 8 6	„ „ „
September „	2 8 0	„ 2 14 0	„ „ „

There has, in fact, on the whole been a distinct rise of 8 annas per maund or, say, ℞13-8-0 per ton during the year. In May last, when bazaar cake was selling at ℞1-14-0 to ℞2-2-0 per maund, the British Indian Oil Mills sent their material to Japan at ℞1-7-0 per maund f. o. b. Calcutta.

The composition of bazaar castor cake may be seen from the following typical analysis:—

Moisture	7·67
Organic matter	82 78
Lime	·83
Phosphoric acid	3 07
Alkalies, etc.	3 31
Sand	2·34
TOTAL	100·00
Nitrogen	6·46

Other commercial samples gave nitrogen 6·45, 6·52, and 6·07 per cent, respectively.

The castor cake produced and sold by the British Indian Oil Mills give figures as follows:—

Moisture	7 53
Organic matter	86 51
Lime	·20
Phosphoric acid	1·41
Alkalies, etc.	2·95
Sand	1 40
TOTAL	100·00
Nitrogen	4 12

Other commercial samples gave nitrogen 4·38 and 4·36, respectively.

The cake supplied by the British Indian Oil Mills Company is always sold as fine ground meal: the bazáar cake usually in the form of small pressed cakes. It has been objected in tea culture to the meal, that in consequence of its fine state of division its effects are very temporary, but as yet this is by no means certain.

Other cakes than those already mentioned are hardly used in Bengal at all, or if used do not enter in any way into trade.

It is evident from the summary that has been given that the use of commercial fertilisers in Bengal, Eastern Bengal and Assam is, except as regards oilcakes, in its infancy. As regards such materials as superphosphate, dissolved bones and the like, I feel almost certain that the prices will have to be materially reduced before there is even the remotest possibility of their use taking on a great extension even in planting and still more in ordinary country agriculture. In the case of bones and bone meal, caste difficulties will prevent the extension of their being anything but very slow. With saltpetre there is more likelihood of larger quantities being used in the near future, but here again demonstrations will have to be multiplied largely before this result is likely to be brought about. Cakes are already used in much of the area, and their use is spreading fast without any Government interference.

MEMORANDUM ON THE USE OF, AND TRADE IN, COMMERCIAL FERTILIZERS IN SOUTHERN INDIA, BY DR. LEHMANN, M.A., B.S.A., PH.D., AGRICULTURAL CHEMIST TO THE GOVERNMENT OF MYSORE.

Having been asked by the Board to collect information regarding the commercial fertilizers in Southern India to assist in the discussion as to whether a law controlling the sale of commercial fertilizers in India would be desirable or not, I have the honour to state that Mr. Benson collected samples of all the commercial fertilizers he could find on the market and forwarded them to me for analysis. In all 137 samples were received from 13 firms. Most of these firms are milling bones and oilcakes with machinery Many of them are large European firms which devote only a small part of their energies to the sale of commercial fertilizers. But a few firms are devoting their entire time and energy to the manufacture and sale of fertilizers. Chief of these in Madras is the Presidency Manure Works, of which Messrs. Parry & Co. are Managing Agents. They have made sulphuric acid in their works, and have been experimenting with considerable success with the manufacture of superphosphates. Messrs. Stanes & Co, of Coimbatore, are manufacturing a neutral sulphate of potash out of the acid sulphate of potash obtained as a by-product from the Cordite Factory at Wellington. The same firm is also manufacturing a considerable quantity of dried blood manure in several of the larger cities of Southern India. Besides these, the only commercial fertilizers produced in Southern India are saltpetre, both refined and unrefined, ground oilcakes, milled bone meal and milled or dried fish, which are all produced in considerable quantities. Prawn skins which are naturally met with in only small quantities need hardly be mentioned here.

Extent of Trade.—As to the extent of the trade in commercial fertilizers in Southern India, no figures could be obtained, as only one small European firm gave any figures regarding the extent of their sales. All the firms state that the bulk of the fertilizers are sold to the European planters, and that the demand for commercial fertilizers varies with the prosperity of the planting industries.

The demand by the native agriculturists is, barring oilcakes, which are used for sugarcane, very small at present, and is chiefly confined to experimeting with them. On this point Messrs. Parry & Co. wrote: "With the exception of that from European planters, the demand for the manures mentioned in the list given in your letter under reply can hardly be said to exist at all when the enormous area under cultivation in India is considered. By means of advertisement in local Agricultural Vernacular Journals and the employment of travelling agents ryots are beginning to be interested in chemical fertilizers, and a small demand, mostly for experimental purposes, is being created. The prospects of future increase depends very largely on the support of Government. If the Agricultural Departments would take up the analyses of soils and advise the ryots what fertilizers to order, a demand would almost certainly spring up

among the educated farmers." On this point the Secretary of the Kristna Agricultural Association wrote after saying that fertilizers were only being used by the ryots experimentally: "There is not the slightest doubt if respectable tradesmen take up the sale of imported fertilizers, their use will become an assured fact." Judging from inquiries I have received regarding commercial fertilizers there is undoubtedly an interest being awakened in the minds of the native cultivators in regard to commercial fertilizers. Whether that interest will grow and lead to a general use of commercial fertilizers will, I should think, depend on the success those who try them first will have when using them.

But although no figures are available as to the extent of the fertilizers actually used, the fact that 137 samples were found on the market at one time (regardless of the brands held by firms such as Messrs. Arbuthnot & Co., from which no samples were received, and that some brands, if they may be so called, were sold out and others not procurable this year) and that at least 13 firms, some of them large European firms, are actively engaged in the sale of commercial fertilizers indicates that in South India there must be a considerable demand for commercial fertilizers.

Composition.—Most of the fertilizers sold in Southern India are liable to very great variations in their composition. This is partially due to adulteration and partially to intrinsic differences in composition of the material used for their manufacture. White castor poonac and dried fish manure are at present the fertilizers most grossly adulterated. This adulteration has increased very materially during the last eight years, especially with white castor poonac. Before this fish was already being adulterated with sand up to 50 per cent. and even 60 per cent. of the weight sold. An adulterated sample of white castor cake produced in or near Bangalore should contain 7 or 7½ per cent. of nitrogen. But it is difficult now to get white castor cake here in any quantity which contains 6½ per cent. of nitrogen, and it occasionally drops down to 4½ per cent. The latter represents an adulteration of over 6½ per cent. of the original weight. This great increase in adulteration has been due to the great increase in the demand for white castor, which eight years ago was the cheapest form in which nitrogen could be bought in Bangalore. Now safflower cake, locally called "*kardai*," imported from the Bombay Presidency is one of the cheapest forms, if not the cheapest, in which the Mysore planters can buy their nitrogen. But the variations in that of oilcake are even greater than those in white castor, for its nitrogen content has been found to vary from about 2½ per cent. to nearly 8½ per cent. But, fortunately for the Mysore planters, the firm supplying this oil cake has voluntarily agreed to guarantee their manures and has equipped a small laboratory for the purpose of testing their oilcakes before they are sent out. How far this variation in the composition of safflower cake is due to adulteration and how far to variety, or the locality where the seed is grown, has not been determined in any way.

That white castor-oil cake varies very much with the locality has been pointed out by Dr. Leather some years ago, Bengal producing a cake which contains nearly 8 per cent. of nitrogen, and Bombay one which contains not much more than half that quantity. As already stated, pure white castor cake in Mysore generally contains between 7 per cent. and 7½ per cent. of nitrogen. One sample, out of which nearly all the black husks had been removed, contained 8·69 per cent., but the samples of white castor from the west coast of Madras, though apparently fairly pure, contained only about 4½ per cent. This variation due to variety has been more clearly proven in the case of dried fish. Different varieties of fish which had been caught near Marmagoa about the same time were carefully dried to prevent admixture of sand and analysed; calculated to the same water content (4·41 per cent.) the following variations were noticed :—

Nitrogen	5·17 per cent.	to 8·72 per cent.
Phosphoric acid	2·26 „	to 6·12 „
Insoluble residue	3·54 „	to 9·73 „

The sample containing least nitrogen also contained the least phosphoric acid and insoluble residue and *vice versâ*.

Honge and *neem* oilcakes as produced in Mysore are as yet fairly constant in composition. And there is not much more variation when all South India is being considered. In *Ippe* (*Bassia latifolia*) there is, however, an enormous

difference due to variety. Dry blood is generally *very* constant and bone meal fairly so. But of the latter some badly adulterated samples have been noticed. These latter were ground very fine and contained a lot of sand.

Of the so-called "chemical" commercial fertilizers, saltpetre and perhaps sulphate of potash are the only ones produced at present on a large scale. In saltpetre very great variations occur. There is no sharp line of demarcation between the so-called refined and crude saltpetre. The material sold under one or other of these names or simply as "saltpetre" has been found to vary from 3·62 per cent. of nitrogen and 17·9 per cent. of potash to 13·61 per cent. of nitrogen and 46·93 per cent. of potash.

Guarantee.—The object of a guarantee for commercial fertilizers is two-fold. The one is to enable the purchaser to know what he is buying, so as to enable him to get what he desires at the lowest possible price per unit, by figuring out the price per unit as given in the last column of the various tables of analytical results sent herewith. The great variations which exist in fertilizers of the same name makes it impossible for him to know what he is buying when the name only is given. A number of firms dealing in commercial fertilizers refuse *at present* to give a guarantee of any kind. They may state that an analysis made some time ago gave such and such results, but decline to say that their present stock is represented by that analysis; some others, chief of which is the Presidency Manure Works, guarantee their fertilizers if asked to do so. For saltpetre no guarantee of any kind is obtainable now in South India by the agriculturists who may wish to use that fertilizer.

The other advantage of a compulsory guarantee is that it protects the honest dealer from the dishonest, careless or grasping competitor. The great difference in price per unit charged indicated that the trade is not at present built on a sound foundation. In countries where a fertilizer law exists the price per unit of each of the chief ingredients of plant food must be fairly uniform when supplied in the same class of fertilizer. But in South India fertilizers, even those imported from countries where fertilizer laws exist and which must cost practically the same per unit to land in India, vary very much in price per unit. Take, for example, the price per unit of nitrogen in sulphate of ammonia. When comparing the prices charged by various firms for this fertilizer differences of over 50 per cent. are met with. In Basic slag differences, of nearly 100 per cent. exist in the price per unit of the phosphoric acid contained in them, and in the price per unit of nitrogen in oil-cakes nearly as great differences are met with.

Why is a fertilizer law desirable.—Two of the reasons have already been given in the previous paragraph. It may be urged that as at present the principal consumers of commercial fertilizers are the planters, and these can insist on a guarantee being given them without the assistance of a fertilizer law; such a law is not yet necessary. In a measure this may be true, but as a considerable number of planters are at present not in the best financial circumstances and are more or less in the hands of their agents who "prepare" and ship their "crop," they are bound to purchase fertilizers from them whether they receive a guarantee with these fertilizers or not. Furthermore, even those planters who are perfectly free to buy where they please find it more convenient to purchase the fertilizers they require from the agent who prepares their crop. For that crop has to be sent to the "Coast" in carts, and these carts would have to return empty, unless they take back the fertilizers required on the estate. Some planters no doubt insist on a guarantee and get it, even if they have to purchase their fertilizers abroad. The manager of one group of estates has just written that he is going to get his saltpetre from Calcutta, as he could not get it with a guarantee in South India. As the planters as a whole cannot insist on a guarantee for the fertilizers they purchase, it makes it much more difficult for those who can insist on a guarantee to get it. I have also been told that some of the firms are not free agents to give guarantees as they please, but do not know how much truth there is in that.

However, a much stronger reason than any of these exists, I believe, to make it desirable to have a proper fertilizer law to control the sale of fertilizers. At present it is, I believe, almost impossible to compel a guarantee being carried out even when given, unless both the person who gives the

guarantee and he to whom it is given live near enough to a chemical laboratory to be able to summon the analyst to appear as a witness in court. I have had to refuse analysing a sample of fertilizer sold under a guarantee and duly sampled and sealed, because I could not afford the time to appear in court to give evidence. The person sinned against in this case was a firm on the West Coast which had exported the fertilizer for which they had received a guarantee to Europe. How the matter was settled I do not know; the sample, with seals unbroken, is still with me. To enforce a guarantee for a fertilizer through an action in court is, I fear, practically impossible, unless a fertilizer law is introduced. Both the sampling and the final conviction in court present endless difficulties, unless there is a law introduced authorizing certain persons to take the samples and the same, or other persons, to make the analyses, and authorizing the courts to admit the samples and analyses to be correct without insisting on the analyst and sampler to appear in court as witnesses, except in special cases.

The view of the planters of South Mysore in regard to the desirability of an Act to control the sale of fertilizers may be best stated by giving the following resolutions passed unanimously at the last meeting of the United Planters' Association of Southern India:—

"That this Association views with regret the disapproval by the Government of India of the institution of any inquiry into the question of legalizing the sale of artificial manures as intimated by the Board of Revenue, Madras, in their Proceedings dated the 10th May 1906, and to learn thereby that the Officiating Inspector General of Agriculture proposes to take no further action in consequence. This Association is of opinion that the necessity for some control over the sale of artificial fertilizers is yearly becoming more urgent in view of the probability of the spread of the use of such manures among the ryots of the country as a consequence of the improvements in agricultural methods following the work of various Agricultural Colleges and Societies.

It is also of opinion that a short Act covering such control might easily be drafted which would bring no hardship to any but intentionally fraudulent vendors of manure, and that the provisions of such an Act could be enforced on somewhat the same lines as adopted by the United States of America, where it is controlled by the Commissioner of Agriculture, the State Chemist or the Director of the Experiment Station, and is therefore not in the hands of any subordinate officials, the only person employed outside the laboratory staff being a properly authorised sampler.

The Planters of Southern India have for some years past urged the necessity for legalised control; most of the largest manufacturers and vendors of such manures are not averse to—and some would welcome—it; but it is impossible for them to exercise the necessary control, unless aided by some enactment which would bring all vendors of chemical or prepared artificial manures under its provisions.

With a view of in no wise retarding the use of artificial fertilizers it would appear wiser to introduce legislation now instead of waiting until fraudulent practices have assumed larger proportions, as must certainly be the case with an increased demand, and thus to check the establishment of such fraudulent practices before they become as well established as they are in some industries in the country.

For further details with regard to the desirability of fertilizer control and for its introduction at the present moment, attention is directed to the full discussion on the subject, copies of which are enclosed.

This Association would therefore earnestly urge a reconsideration of the recent decision of the Government of India, and request that a searching enquiry be instituted with a view of the early introduction of some system of control on the lines existing in the United States of America."

Among the dealers in commercial fertilizers there is not yet that unanimity in favour of such an Act as there is on the part of the planters. But they have not yet studied that subject as carefully nor as long as the planters have done. A few firms may still be opposed to any *immediate* legislation controlling the sale of fertilizers, though they all admit the necessity for it at some future time. Chief of these was, I believe, the late firm of Messrs. Arbuthnot & Co. At the last meeting of the United Planters' Association of Southern India, to which all the firms dealing in commercial fertilizers in Southern India known to the Secretary were invited, Mr. Strickland, the representative of Messrs. Arbuthnot & Co., stated that the view of their firm was that they did not see the necessity for legislation at present. That might be necessary in the future when the ryot took to using fertilizers. But, judging from the conversation I have had with the members of two other firms, who were opposed to the immediate introduction of a fertilizer law, I am convinced that most if not all the objections to a law controlling the sale of fertilizers is due to the fact that the advantages of the law are not properly understood, and that *supposed* difficulties which do not really exist appear to be in the way. I can safely state that the majority of the firms dealing with fertilizers in South India are in favour of a fertilizer control being introduced. I may as well repeat what some of them have written. Messrs. Parry & Co., when writing about this subject, stated: "* * * We welcome the proposal to introduce a system of scientific control over the sale of commercial fertilizers in India * * *" Mr. Jackson, one of the members of that firm (who are, as already stated, the Agents of the Presidency Manure Works), as well as Mr. Bernard, the Manager of these Manure Works, attended the United Planters' Association of Southern India meeting and helped the proceedings materially. Messrs. Coen & Co, of Hubli, who were not represented at the United Planters' Association of Southern India meetings, wrote: "With reference to your circular letter No. 1346, dated the 4th June, we beg to state that we are in accord with the proposal that a system of control should be introduced over the sale of commercial fertilizers in India, more especially in regard to the furnishing of a guarantee of quality." This firm deals principally in ground oilcakes and bone meal. The Manager of Messrs. Matheson & Co., of Hunsur, writes: "I certainly think a system of control is desirable, specially so in chemical manures, where analyses can easily be got from manufactures; but the difficulties in the way of doing this satisfactorily with oilcakes are almost too great to be surmounted in our case, I fear." In speaking of the difficulties to be encountered, he states when speaking about a guarantee for oilcakes: "* * * Before this could be done, there must be a recognised place to send all manures, and some arrangement made so that both parties are satisfied that a fair sample has been taken; if not, there will be endless disputes."

Messrs. Fett & Co., writing to the Chairman of the United Planters' Association of Southern India, stated: "With, we presume, all other manure merchants in India we should welcome any law which would prevent fraud, but it would be useless to restrict this to fertilizers imported into this country: such fertilizers as nitrate of soda, sulphate of ammonia, superphosphates and potash salts are usually in the hands of well-known syndicates, who have a reputation to sustain, and their guarantee is considered sufficient all the world over * * * * In the matter of indigenous manures, however, there is much scope for improvement, and there is a crying need for a law prohibiting foreign admixture into oilcakes and fish, and a guarantee of the purity of saltpetre. Every manure merchant would welcome this in his own interests and those of the public."

Messrs. Saldanha & Sons wrote: "We are of the opinion that it is highly desirable to organise a system of control whereby the quality of fertilizers be guaranteed to the purchaser, especially chemical fertilizers * * *"

This will, I think, suffice to indicate that there is a strong feeling in favour of an immediate introduction of a fertilizer law controlling the sale of commercial fertilizers both among the dealers and the consumers.

I may add that all District Associations which have expressed their views on the subject are strongly in favour of a fertilizer control and would include all fertilizers under the same. But, in order that a fertilizer law may be worked successfully, it requires not only the support of both consumer and producer,

but also a Government Agency to carry it out; and in this will, I fear, be found the chief difficulty in bringing a law into effect just now. Naturally the work involved in the carrying out of a fertilizer control must fall upon the various departments of Agriculture, especially, or almost exclusively, on the Chemists of these departments. And up to the present very few of the departments of agriculture had a Chemist on their staff, and it was therefore impossible to establish any sort of fertilizer control in the past. But as soon as the various departments have their Chemist and he has his laboratory and assistants in working order there ought to be no difficulty in undertaking this control. In the United States of America these analyses are done in regular factory fashion, and I know of one laboratory in which a Chemist with four assistants claims to have analysed 4,323 samples of fertilizers and fodders, in connection with the control of these substances, in addition to considerable other work. But it will take a very long time before Indian assistants will be able to make analyses at this rate and retain a sufficient degree of accuracy. Two assistants would however, I think, be likely to do all the work required at present for an effective fertilizer control in any of the Presidencies or Provinces of India by devoting half a year to that work.

In conclusion, it may be well to consider if any useful purpose can be served by postponing the introduction of a fertilizer law which, in the opinion of all who have expressed their views on the subject, it would be desirable to introduce at some time or other. The fact that all dealers agree that such a law would be of advantage now or at some future time indicates that they are quite prepared to have the composition of their fertilizers known, and that if they should be unable to supply a fertilizer as cheaply per unit as some of their competitors, they are willing to let them sell that brand and devote the portion of their energies and time formerly spent on that brand to some other line of fertilizers or some other line of business. It is also practically certain that with a fertilizer law the relatively expensive fertilizers (as, for example, Kainit, in which the unit of potash costs often almost twice the money it is sold for by the same firms in the form of "muriate" or saltpetre) would disappear from the Indian market altogether. The inevitable result would be that with a satisfactory fertilizer law the consumers as a whole would be able to get their plant food at a cheaper rate than they now do even if the demand for fertilizers should remain the same as it is now. All the indications point in the direction that the native cultivator is likely to make use of commercial fertilizers in the near future. When this is the case and a comparatively large number of relatively illiterate men buy small quantities of fertilizers, the temptation for an unscrupulous man to become a dealer in commercial fertilizers is certainly great, and from the experiences we have he is not likely to leave such a field unoccupied for long. That an increased demand in fertilizers is liable to lead to adulteration is indicated by the adulteration which has taken place in dried fish and white castor cake (and probably also in safflower cake) in the past. That fraudulent adulteration of fertilizers must injure their usefulness and retard their extensive application is practically certain. It is also practically certain that frauds once established are hard to put down. And by punishing evil doers more ill-feeling is created than by preventing them from doing their evil-deeds. All this points, I take it, to the fact that the sooner a fertilizer law is introduced, the better. Besides it will be easier to introduce a law like this when practically everyone is in its favour than later when fraudulent men have become dealers and are sure to oppose a fertilizer law in every way in their power. Finally, it is much pleasanter, I take it, to gain the experience in administering a law like this when we need fear nothing but friendly criticisms than later when more or less animosity is almost certain to be developed. Besides, the law is likely to work much more easily and smoothly ever afterwards if started with a mutual feeling of trust and confidence on the part of every one concerned.

What the law should be can, of course, be only discussed after it has been decided to have a law.

About the way the law has worked in other countries I can add but little to what was said last year. It works well in the United States of America. A Committee to unify the law of the various States has ended its sittings, but their report, which was promised me, has not yet been received. In Ceylon a

fertilizer law has been working very satisfactorily, but I have not yet received the details of that law, but may be able to give them at the time of the meeting.

List of firms who sent samples of fertilizers regarding fertilizer control.

	Number of samples sent.
Messrs. Best & Co., Madras	1
„ Parry & Co., Madras, for Presidency Manure Works	57
„ Stanes & Co., Coimbatore	20
„ Peirce, Leslie & Co., Coimbatore (charged for samples)	9
„ Matheson & Co., Hunsur	3
„ Petrie Hay and Sons, Hunsur	7
„ Binny & Co.'s Coffee Works, Bangalore	10
„ Croft, Mody & Co., Bombay	4
Mr. R. H. Fett, Bombay	7
Messrs. Morgan & Co., Mangalore	6
„ Saldanha & Sons, Mangalore (other samples sold out)	4
Madras Bone Mills	6
Messrs. W. Coen & Co., Hubli. (Kurdy and Safflower cake not procurable this year.)	
„ Volkart Brothers. (This year only exporting manures to Ceylon.)	..
Kali Works and Manure Factory. (Messrs. Arbuthnot & Co., Calicut and Mangalore, supplies large quantities of fertilizers, but, although written to several times, no samples were received.)	...
Cossim Mahammed's Oil Mills, Mazagon	...
Kurrimbhoy Bone Mills, Mazagon	.
Indus Valley Bone Mills, Karachi	...
Moracoon Bone-crushing and Coffee-curing Works, Tellicherry	...
Messrs. Hollingshurt & Co., Cochin (Milled fish)	
TOTAL	137

Classification of samples of fertilizers received for analysis in connection with the inquiry into fertilizer control.

Milled oilcakes—		
Black castor	7	
White castor	6	
Honge (*Pongamia glabra*)	7	
Neem (*Melia azadirachta*)	3	
Groundnut	1	
Kurdi (*Carthamus tinctorius*) (generally sold in large quantities)	..	
Ippe (*Bassia latifolia*) (generally found on the market in Mysore)	...	
	—	24
Milled bones, fish, etc.—		
"Fine" bone meal	17	
"Steamed" bone meal	3	
Boan char	1	
Milled fish	5	
Prawn skins	1	
	—	27
Nitrates, etc.—		
Saltpetre	5	
Nitrate of soda	3	
Sulphate ammonia	3	
Dried blood	2	
	—	13

Pure phosphatic fertilizers—		
Superphosphates (two of Indian manufacture)	7	
Basic slag	4	
Christmas Island phosphate	1	
Trichi phosphates (largely advertised)	...	
	—	12
Potash fertilizers—		
Sulphate of potash (including one of Indian manufacture)	5	
Mixed sulphates of potash and soda	2	
"Muriate" of potash	4	
Kainit	3	
	—	14
Mixed fertilizers	17	
	—	47
TOTAL		137

TABLE XI.

Results of analyses of oil cakes and dried blood.

Number.	Substance	Results of previous year's nitrogen.			Results of 1903-03.						Price per ton	Value per unit of nitrogen making no allowance for potash or phosphoric acid.
		Average	Maximum.	Minimum.	Nitrogen.	Loss on ignition after drying.	Phosphoric acid.	Potash	Insoluble residue.	Source.		
1	2		4	5	6	7	8	9	10	11	12	13
											R a. p.	R a. p.
...	White Castor	6·37	8 69	4·53	.	...	..	...	..	...	...	...
365	Do.	...	...	...	4 25	84·11	1·83	0 80	3·14	Madras West Coast	60 0 0	14 1 10
309	Do.	...	...	..	4·95	87·15	1·04	0·93	1·83	Do.	60 0 0	13 1 11
286	Do.	...	..	..	5·26	80·98	1 87	0 96	2 81	Madras East Coast	72 0 0	13 11 0
299	Do.	...	...	..	5 46	85·93	2 27	0 85	2 08	Madras	77 8 0	14 3 1
344	Do.	...	...	..	6 22	84 78	2 27	.	2 57	Mysore	66 0 0	10 15 2
330	Do.	..	...	...	6 23	85 00	2·29	0·76	2 60	Do.	57 8 0	9 2 5
319	Black Castor	..	..	...	3·99	..	1·86	.	10 64	Do	...	
331	Do.	...	...		4 22	..		.	.	Do	49 0 0	11 6 0
317	Do.	..	...	..	4 38	85 50	1·74	0 88	2 25	Do.	50 0 0	11 8 9
308	Do.	..	...		4 61	.		.		Madras West Coast	57 8 0	12 6 3
363	Do.	...	..	...	4 74	81 95	2 01	1 02	2 98	Do. do.	50 0 0	10 8 9
307	Do.	...	.	.	4 78	84 71	2 09	0 51	2 83	Madras	57 8 0	12 0 6
300	Do.		..		4 89	84 15	1 76	0 88	3·51	Do.	65 0 0	13 4 8
...	Honge (Pongamia glabra)	3·83	4 01	3 59	.	..	.	...	.		...	...
360	Do. do	..		.	3·37	.		...	..	Madras West Coast	47 8 0	14 1 6
329	Do. do.	..	..		3 93	86 36	1·10	1·09	2 61	Mysore	10 0 0	10 3 3
301	Do do.	...		.	4 03	88 04	0·88	1 26	1 53	Madras	57 8 0	14 2 3
287	Do. do.	.	.	.	4 05	85·91	1·50	1 06	2·36	East Coast	50 0 0	13 5 6
334	Do. do.	...		...	4 05	85·73	0 90	1·21	3·02	Mysore	40 0 0	9 15 10
343	Do. do.		.		4·11	85 09	0·88	1 05	3 07	Do.	45 0 0	10 15 2
...	Neem (Melia azadirachta)	4 86	4·12	0 99	.	.	.	.	...		..	
298	Do. do.	...	..	..	3 89	83 20	0 02	1 83	4·98	Madras	62 8 0	16 1 1
335	Do. do.	..	..	...	5·11	81 93	1·12	1 84	2·77	Mysore	45 0 0	8 13 10
283	Do. do.	..		..	5 38	82 09	1·20	2 19	5 31	Madras East Coast	50 0 0	9 1 8
...	Ippe (Bassia latifolia)	2 97	1·14	1 80	..	.	..	..	...		...	...
..	Kurdi (Carthamus tinctorius)	5 70	8·30	3 22	..	.	...	...	...		...	...
56	Do. do.	...	..	..	2 58	94·98	1 37	0 80	1·39	Madras	...	...
285	Ground-nut	...	..	..	7 80	88 33	1 60	1 19	1·77	Madras East Coast	70 0 0	8 13 11
262	Til	..			4 93	.	...	...	.		...	...
..	Dried blood	...	11·55	10·10	..	.	...	...	..		...	...
304	Do.	...	...	..	11·51	81·18	0 42	...	5 81	Madras	115 0 0	10 0 0

TABLE XII.

Results of analyses of bone meal, fish, etc.

Number	Substance	Results of previous years — Nitrogen: Average	Maximum	Minimum	Phosphoric acid: Average	Maximum	Minimum	Results of 1905-06 — Nitrogen	Phosphoric acid: Total	Citrate soluble	Potash	Insoluble matter	Moisture	Loss on ignition	Locality	Price.	Cost per unit: Nitrogen	Phosphoric acid
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
																R a. p.	R a. p.	R a. p.
	Milled fish	5 86	8 72	3 00	1 79	7·51	1 73									..	.	...
77 Z	Do.	..		..				3 91	1 20	.		40 01	9 19	..	Madras West Coast			
361 F	Do	.		.		.	.	1·30	3 73	.	..	40 13	5 29	41 65	Do .	50 0 0	9 8	2 6 3
3[illegible]6 „	Do.							4 97	4 99	.	..	32 92	1 11	19 79	Do. .	43 8 0	6 15	1 12 0
302 „	Do.	.	.	.	...	..	...	5·14	4 71	.	9	33 23	3 74	18 67	Do .	72 8 0	9 8	2 6 2
310 „	Do		.			.		5 5[illegible]	5 35		..	26 35	3 22	51 71	..	55 0 0	7 15 3	1 15 10
362 „	Do	..		..				6·23	5 71	...	...	34 41	1 02	45 05	... .	50 0 0	6 7 8	1 9 11
30 „	Prawn skins	.			.	..		1 93	2 84			22 3	4 37	16 05	Madras West Coast	85 0 0	14 14 10	3 11 8
9 Z	Do	8 14		..	3 37	..		..	..	..	..	4·17	.	78·46	Do. .		.	...
	Bone meal	3 61	4 04	2 52	22 45	23 36	18 62	.	..	..	..	.	...	.		..	..	.
357 F	Do.	.		.	..	...	..	3 77	21·14	.	...	6 25	5 91	31·54	Madras West Coast	70 0 0	7 11 8	1 14 11
341 „	Do	.	.	...	...		.	3 86	21 10		.	4 02	6 41	34 8	Mysore .	60 0 0	6 7 8	1 9 11
368 „	Do	..	..	..		.	.	3 73	21 9	..	.	5 99	6 28	31 14	Madras East Coast	62 0 0	6 11 9	1 10 11
333 „	Do	..	.	...		.	.	11	22 18			1 06	6 53	31 79	Do. West Coast	57 8 0	5 15 5	1 7 10
297 „	Do	.	...	.	.	.		3 73	23 97	9 06	..	2 47	5 82	29 96	Madras .	75 0 0	7 11 4	1 14 10
316 „	Do	..	..	..	..	...	..	3·05	24 04	6 91	.	1·14	5·93	32 14	Mysore .	56 0 0	6 10 0	1 6 6
371 „	Do	..	..	..	..	...		1 25	24 22	..	.	·16	6 63	33 69	Madras East Coast	64 0 0	6 3 4	1 8 10
309 „	Do steamed	.	..		.	.		3·93	24 6	..	.	3 4	4 35	30 31	Do. West Coast	70 0 0	6 15 0	1 11 9
367 „	Do .	...	...	...	.	..	...	4 00	24 67	.	.	2·91	4 87	30 16	Do. .	68 0 0	6 11 9	1 10 9
333 „	Do steamed	..	...	..	.	..		3 91	21 7		.		6 46	58	Mysore . .	60 0 0	5 15 2	1 7 9
296 „	Do do.	..	.	.	..		...	3 96	25 09	11 29	..	..	5 29	30 6	Madras . .	85 0 0	8 5 0	2 1 3
320 „	Do. after boing in soil 28 years.	.	...	.	..	..	.	1 62	24 5	11 86	23	..	...	...	Do . .	60 0 0	.	...
					..	..			33 19	16 36	..	9·2	3·2	15·47	Mysore . .		.	.
326 „	Bone meal	. ...	..	..	...	.	.	.	22 16	...		5 57	...					
346 „	Bone char	...	..	..	..			1 15	27 69	...	..	7 74	2 46	17·37	Bombay . .	65 0 0	...	.
342 „	Do.	1·21	..	.	27 8	.	.	...	...	..	.	1·11	3 25	20 06	Mysore . .	40 0 0	..	1 7 1
															. ..	...	...	..

TABLE XIII.

Composition of ammonia salts and nitrates.

Number.	Substance.	Moisture	Insoluble residue.	Nitrogen.		Potash.		Received from	Price	Price per unit of	
				Found.	Guaranteed.	Found.	Guaranteed.			Nitrogen.	Potash.
1	2	3	4	5	6	7	8	9	10	11	12
									R	*R a. p.*	*R a. p.*
272	Sulphate of ammonia	...	0·03	20·60	...	..	...	Madras East Coast	225	10 15 3	
239	Do.	..	0·11	20·19	20·00	...	...	Madras	330	16 4 1	
312	Do.	0·17	1·78	20·13	..	...	...	Do.	315	15 10 1	...
291	Nitrate of soda (Chili saltpetre) . .	0·20	0·12	16·38	15·00	..	...	Do.	255	16 0 3	...
338	Do.	0·17	0·34	16·03	...	...	..	Mysore	300	18 10 6	...
353	Do.	0·60	0·10	15·75	15·60	...	...	Bombay	210	13 5 1	...
219	Refined saltpetre (Nitrate of potash) . .	0·05	0·03	13·01	...	46·93	..	Madras	..	...	...
294	Do.	0·60	0·23	11·62	8·10	40·16	35·59	Do.	205	8 15 7	2 9 0
66	Do.	3·00	...	9·83	...	38·36	...	Do.	...	...	...
237	Saltpetre (Nitrate of Potash) . . .	0·46	0·14	10·10	...	35·78	...	Mysore	125	6 1 11	1 12 0
295	Crude saltpetre	1·25	0·12	7·18	3·10	23·88	18·25	Madras	105	6 14 10	1 15 8
	Average of crude saltpetre analysed in former years.	0·18	...	3·62	...	17·90	...				

TABLE XIV.

Composition of phosphoric fertilizers other than bonemeal, dried, fish etc.

Number	Substance.	Water.	Insoluble in lime.	Iron and Aluminum oxides	Potash	Phosphoric Acid: Water soluble: Found.	Phosphoric Acid: Water soluble: Guaranteed	Phosphoric Acid: Citrate soluble: Found	Phosphoric Acid: Citrate soluble: Guaranteed.	Phosphoric Acid: Total: Found	Phosphoric Acid: Total: Guaranteed.	Passed through standard sieve 100 meshes to the inch: Found	Passed through standard sieve 100 meshes to the inch: Guaranteed	Price	Price per unit of Phosphoric Acid: Available	Price per unit of Phosphoric Acid: Total
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
														R a. p.	*R a. p.*	*R a. p.*
304	Trichi Phosphate	..				.		·38	...	25 51	...	99 00	..	.	...	...
284	Christmas Island phosphate	37	·06		..	..		.	.	39·13	...	51·59	.	100 0 0	...	..
293	Basic slag	·285	9 25	.		.	...	.	. .	15 05	16 18	83 63	...	100 0 0		6 4 8
311	Do.	228	10 16			..	.		...	11 2		89 86	.	95 0 0	..	6 11 0
356	Do.		11 12	.	..	.	..	...	13 41	14 4	14 00	90·10	81 6	95 0 0		6 9 7
359	Do	·175	8 1	.	..	. .			...	20·01	..	87 32	...	70 0 0	.	3 7 11
283	Superphosphate	6 6	...	...	. .	16 37	.	1 06	..	18·13	...	...	...	108 12 0	6 0 6	...
292	Do.	7 04	...	...	..	21·67	...	2 21	...	23 88	20 23	...		150 0 0	7 1 11	...
314	Do	10 79		...	. .	17 6	.	3 09	..	21·15	...	...	..	130 0 0	6 1 8	...
354	Do.	3·79	...	...	.	17 17		2 83		20 19	15 16	...	..	115 0 0	5 12 0	5 9 10
355	Do	11 23	...	.	.	37 27	42 14	..	3·66	42 83	41 43	.	...	185 0 0	..	4 5 1
72	Do.	...	...		..	11 71	...	..	..	18 13	...	..	...		.	...
73	Do.	..	...	...		13 67		.	...	14 00	...	.	...	..	. .	...
76	Do.	...	...	...	.	12 04	.	68	. .	29·35	...	...	...	...	...	...
305	Bone Superphosphate and Potash	2·76	.			2 20	..	9 70	...	15 65	...		.	80 0 0	...	...
81	Do.	3 01	..	...	9 76	2 93	..	8·67	..	17 55	...	...	...	...	.	...
82	Do	.		.	4 07	·2		8 16	...	19 2		.	...	...	..	...

TABLE XV.

Showing composition of potash fertilizers.

Number.	Substance	Water.	Insoluble residue	Potash, water soluble		Chloride	Sulphuric acid	Received from	rice per ton.	Cost per unit of Potash	
				Found.	Guaranteed					Considering Potash only	After deducting Nitrogen.
1	2	3		5	6	7	7a.	9	9	10	11
									R a. p.	R a p.	R a. p.
75	Double sulphate of potash and soda	0 12	1 48	31·63	...	0·16		Madras	.	...	...
79	Do. do	..	2 00	32 38	...	0 88	...	Do.	..	...	...
83	Stanes' sulphate of potash	...	8 23	45 13	40·00	..		Do.	130 0 0	2 10 6	..
283	Sulphate of potash	0 10	0·45	51 93			41 43	East Coast Ma'ras	197 8 0	3 13 5	.
290	Do.	...		.	51 00	...	..	Madras	350 0 0		.
313	Do.	0 37	0 64	41 06	...	.	41 23	Do.	235 0 0	5 5 4	..
352	Do	0.18	0 77	46 68	48 60	...	43 97	Bombay	190 0 0	4 1 3	...
281	Muriate of potash	0·18	0.30	53 82	..	48 37	.	Madras East Coast	168 13 0	3 2 2	..
315	Do	0 08	0 59	58·63	..	49 03	..	Madras	210 0 0	3 9 4	.
336	Do.	0 09	0 23	51·92	51·10	49·39		Mysore	260 0 0	5 0 1	
351	Do.	0 42	0 16	54·68	50·50	48 57		Bombay	170 0 0	3 1 7	.
260	Kainite	1 28	1·14	12·35			17·10	Madras East Coast	77 8 0	5 14 8	...
339	Do.	0 33	0 88	13·70	...	...	17 21	Mysore	80 0 0	5 13 5	..
350	Do	2 68	1 09	13 35	12·10	...	15 09	Bombay	70 0 0	5 3 11	
294	Saltpetre	0 60	0 23	40 16	.	...		Madras	215 0 0	5 1 1	2 9 0
295	Do.	1·25	0 43	26 88	.	...	.	Do	165 0 0	3 14 6	1 15 8
337	Do.	0 16	0 44	35 78	...			Mysore	125 0 0	3 7 11	1 12 0
	Mixed wood ashes maximum of former analyses	..	...	2 32	...		.				
	Do. minimum do.	...	..	0 40	...	...	.				
250	Lantana ashes	...	..	13·20	..	...	..	Mysore	...	...	...
	Paddy husks	..	..	1·57	.	...	...	Do.			
	Bamboo	...	.	5 40	...	..		Coorg	..	..	.
	Bratty	.		2 53	.	...		Mysore	...	.	...

APPENDIX F.

PAPERS ON THE UTILIZATION OF SILT.

SIR EDWARD BUCK'S ADDRESS TO THE BOARD OF AGRICULTURE ON THE UTILIZATION OF SILT.

When in the Government of India I made it a practice in dealing with Local Governments, only to put before them broad principles—the broader the better—and to leave it to them to apply the principles in accordance with local conditions Wherever possible, I first took an opportunity to have the principle itself discussed and formulated by a conference representing all Provinces. I would follow this practice now. And the principle which I would place before this assembled Board is that contained in the Resolution passed by an Agricultural Conference in Italy two years ago :—"*It is a 'grave error' not to utilise fertilising silt whenever it can be profitably used.*"

I suggest that there is *primâ facie* evidence that, especially after the first heavy rainfalls, there is a material amount of fertilising silt in many of our rivers and streams and in much of our surface drainage. The abstract of replies to my circular of 1893 given in Appendix C of my Report indicates so much The replies also indicate that it is in some cases profitably used. I do not, however, suggest that any immediate measures involving large outlay should be taken to give effect to the principle which I place before the Board. I only propose that if the principle be accepted, a working-plan should be commenced in each Province, at first, perhaps, only in one or two Provinces, for giving effect to it.

The first step must be, as in the case of all working-plans, a careful investigation of the facts, of the possibilities, and of the methods to be employed. I have suggested in my report that this involves :—(1) An analysis of the fertilising silts available in our rivers, streams and surface drainage ; (2) A map of the drainage system ; (3) A study by our Engineers of the methods adoptable.

In dealing with these questions in further detail I ask permission to confine myself to the United Provinces with which only I am familiar. Conditions no doubt will widely differ in other provinces.

First the analysis of our silts. Dr. Leather has made a good beginning already. We have now a record of silts taken from streams and canals when in flood in some twenty or thirty cases at the commencement of the last monsoon. I only received five of these in Italy where two at least were considered by the Agricultural Chemists who deal with silts in that country to be of material value for agricultural purposes. I have suggested that these analyses should be continued. But I would add the suggestion that in promising cases they should be made in greater detail with still closer reference to the first fall of rain. In Italy analyses are made in some rivers when in flood every two hours and both at varying distances from the bank and at varying depths.

Taking a broad view of the conditions in these Provinces, I would divide the possibilities into three classes :—

I. The capture of silts from streams and connected canals at no great distance from the foot of the Himalayas.

II. The capture of silts from minor and surface drainage throughout the provinces, with simultaneous prevention of erosion.

III. The control of drainage in mountains and hills.

I need say no more about the first class. That is sufficiently dealt with in my report and no action seems to be for the present needed except that already suggested. But I should like to say more about the second class. Here we have not to deal with the silt brought down from the forests of the mountains but with the silt washed from the surface of the plains themselves. Now I contend that the silt absorbed in the first rainfall—I would go further. and say the first hour of rainfall—may be of considerable manurial value, and if so that none of it should be allowed to escape. What are the conditions ?

As a rule (I am sorry that this year is the exception to the rule) there are some five months—say from January 15th to June 15th—in which not a drop of rain falls. During those months a considerable quantity of human and cattle manure (all of which latter is not burned) is deposited on the surface of the land. It is desiccated by the sun and hot air and brought into a condition in which much of it is readily taken into solution by the first hour's fall of heavy rain. Probably the drainage water of the first day or two's rain contains some fertilising ingredients not only in solution but in the form of silt, including a material washing from the surface of manured fields as well as from village lanes, and houses, the walls of which are covered with nitrates (often scraped off for manuring tobacco and opium), in addition to what may be washed from the open lands.

I was myself led to discover the curious part taken by the first rainfall in the distribution of *reh* where natural drainage had been interrupted over new ground. The *reh* could only be carried where the first drainage could find an opening. It was interrupted by a *band* 3 or 4 inches high. As in the dry weather the *reh* itself painted, in snow white colour, the course which the first rainfall drainage had taken. It was easy to see what had happened. Its distribution was not affected by later drainage of sometimes 2 or 3 feet in depth. The maps in the *reh* report on the table open to your inspection clearly illustrate the process. After the first rainfall the *reh* sank in solution below the surface and was not touched by later falls of rain.

Now something of this sort must happen to the early drainage carrying fertilising matter in solution or in fine silt—and if so it would seem that what was an accident in the case of *reh* should be purposely done in the case of the fertilising water of the first drainage. We should *interrupt* its escape into the naturally formed drainage channels and hold it up in places where it can be utilised.

If there is any truth in these conjectures it might be desirable to test the value of the first drainage in suitable places. I may add that the scheme for "doctoring" ravines suggested as famine works would give an opportunity for holding up such if it is found valuable.

There is another question connected with the first rainfall which is still more conjectural. During the five months of dry season, but especially in the last 3 of those months when the strong west winds blow in the day, a material amount of fertilising dust must be taken up in the air. A question was asked yesterday whether *reh* was distributed by the wind. Of course it is. I have seen the east end of an *usar* maidan covered 6 inches deep with *reh* powder flanked by miniature *reh* dunes, and on one occasion when accident obliged me to travel over *usar* plains in a *palki* in May I have carried about a bushel of *reh* blown into it daily to my tents. The same occurs with the desiccated powder of manures on the fields and plains. As the weeks go on the sky becomes more and more obscured with dust raised from the land until at the end of June the sun can hardly be seen however much it can be felt.

Now it would seem worth while at any rate to analyise the first hour's rainfall of the monsoon which is the very rainfall that after reaching the ground carries off so much of the surface manure. May not the manure of the air increase its value and make it more worth while arresting?

You may however consider this too much of an airy speculation, though I believe that much of the unmanured land of the Province owes not a little of continued productiveness to that cause.

The second measure advised is the preparation of a drainage map. I am sorry that a complete map which Mr. Wright and myself made for the Cawnpore District cannot be found, but a portion of it has been re-issued in the *reh* report on the table to which I invite your inspection. Such maps are useful for many purposes and can be, as explained in Appendix D, constructed in two or three years with very little expense.

The Board's views on this question are solicited. The preparation of maps might be at first confined to United Provinces, Punjab and Central Provinces.

The third measure, the study of methods, would be commenced, I suggest by the deputation of an Engineer or Engineers, preferably of the Canal Department, to Italy.

Would the Board advocate this measure?

I may repeat that none of the measures suggested for present adoption involve any material outlay.

REPORT BY SIR EDWARD BUCK, K.C.S.I., LL.D., ON THE UTILIZATION OF RIVER SILT FOR THE FERTILIZATION OF LAND AND THE MITIGATION OF MALARIA.

[Printed separately]

Prefatory Abstract.

REPORT BY DR. J. WALTER, LEATHER, PH.D., F.I.C., ETC., IMPERIAL AGRICULTURAL CHEMIST, ON THE CHEMICAL COMPOSITION OF RIVER SILTS OF THE UNITED PROVINCES, COLLECTED DURING THE MONSOON OF 1906.

With reference to the orders of the Government of India No. 1087-70-7, dated 22nd May 1906, I have the honour to submit my report on the chemical composition of the various samples of silt which have been collected during the past monsoon by the Irrigation Department of the United Provinces.

2. I have only determined those items in the chemical composition of the silt which are likely to prove of service in relation to the enquiry. The results are set out in the accompanying ten statements, one for each river which has been under observation.

The column showing the proportion of carbonate of lime (*calcium carbonate*) will indicate the "chalkiness" or otherwise of the material and this appears to be a definite characteristic of the silt of any one river

The *quantity* of silt varies naturally very much indeed even in the same stream; but if the samples of the Betwa and Dhassan rivers are average specimens, it is clear that their flood water does not contain anything like so much silt as the Himalayan streams.

In chemical composition (excluding the calcium carbonate) there is nothing very striking about any of the samples, they are usually as poor in organic nitrogen as Indian soils are, though there are some exception such as the first sample of the Tons river silt and the Betwa river silt. A good deal of the silt (as for instance that of the rivers Tons, Song and Jumna) is fairly rich in phosphates, but most of this is in a very unavailable form, as indeed one might anticipate from freshly weathered rock material.

Generally, indeed, it may be said that these river silts are not to be considered as supplies of "rich manure" in the chemical sense, and any agricultural value they possess must be referred to some physical influence on the land.

Regarding the thickness of a deposit of silt from such waters, the following data are of interest.—

(*a*) An acre of water 6″ deep = 21,780 cubic feet and if this water contained 1 lb. of silt per cubic foot the quantity of silt is 21,780 lbs.

(*b*) An acre of soil 12″ deep may be assumed to be 4,000,000 (four million) lbs. for the purpose of a rough approximation or an acre 1″ deep = 333,000 lbs.

(*c*) Accordingly, if an acre of land were flooded 6″ deep with water containing 1 lb. silt per cubic foot, and the silt entirely deposited, the layer would be equivalent to about ·066″. It will be seen that the river water only rarely contained much more than 1 lb. of silt per cubic foot and very commonly much less than this.

It will naturally be found, indeed, I know it is fully recognised by the Irrigation Department, that some silt is useful, whilst other silt is harmful, to agricultural land, and this depends not merely on the nature of the silt but also on that of the land. In the District of Dehra Dun, for instance, the soil is generally so stony in character that deposits of almost any kind of "silt" would be found serviceable.

On the other hand, in the Hoshiarpur District of the Punjab, the flood silt has done harm, for it is of a sandy nature, and of lower agricultural value than the cultivated land.

It is clear therefore the silt of any particular stream would be serviceable or otherwise is a question of local consideration.

Statement showing chemical composition of samples of silt obtained from ten Indian Rivers.

Laboratory No	Description	Silt grm per 100 c c	Silt lbs per c ft	Organic Nitrogen	Total Phosphoric acid	Available Phosphoric acid	Available Potash	Calcium carbonate	
				Tons river—(Dehra Dun)					
707—709	Tons river, 31st July 1906	·97	·61	·10	·117	·005	·009	15·16	High flood for two hours.
750—751	„ „ 18th Aug 1906	55	35	08	153	not done—sample too small.		11·99	
776—777	„ „ 29th „ „	1 72	1 07	06	132	Ditto		16 32	
				Song river—(Dehra Dun)					
705—705	Song river, 31st July 1906	1 63	1·02	02	·105	001	001	25 15	Exceptionally high flood for six hours.
721—722	„ „ 3rd Aug. 1906	2 06	1 29	·05	2 00	002	·006	21·27	
718—719	„ „ 18th „ „	6 11	4 01	·01	·110	003	002	17·34	
774—775	„ „ 29th „ „	1 23	77	04	271	003	001	25 18	
				Ganges river—(Hardwar)					
715—718	Ganges river, 3rd Aug 1906	90	56	07	126	015	·011	9 52	
817—818	„ „ 16th Sept „	17	·11	·03	052	·009	015	5 51	
				Kosi river.					
780—781	Kosi river, 2nd Aug 1906	1 97	1·23	01	·077	·001	005	3 97	
782—783	„ „ 6th „ „	1·93	1 16	·07	051	·011	008	2 07	
933—934	„ „ 15th Sept „	89	56	00	072	·012	007	1 95	
				Kichla river.					
888—889	Kichla river, 31st July 1906	73	·19	·05	081	·003	003	5·18	Two bottles received broken and two labels were illegible.
890—891	„ „ 3rd Aug „	2 75	1 72	05	153	·008	010	3 61	
892—893	„ „ 6th „ „	2 62	1 63	05	106	·007	010	5 34	
894—895	„ „ 15th „ „	1 33	·83	04	113	·006	·011	4 80	
896—06	„ „ 17th „ „	1 61	1 01	04	075	·005	·012	3 98	
898—899	„ „ 4th Sept „	89	·56	03	·114	005	009	5 09	
876—879	„ „ 7th „ „	93	61	03	037	·007	·005	1 08	
880—881	„ „ 8th „ „	51	·32	03	117	003	005	8·69	
882—883	„ „ 15th „ „	1·11	·70	03	·126	006	·005	4 10	
				Jamna river at Khara					
723—724	Jumna at khara, 26th July 1906	99	62	03	·120	021	012	8 12	
762—763	„ „ 3rd Aug „	1 56	99	07	111	011	010	3 83	
770—771	„ „ 9th „ „	86	54	05	·100	007	019	3 73	
772—773	„ „ 19th „ „	89	·56	05	·122	012	·012	3 29	
926—927	„ „ 1st Sept. „	2 33	1·30	08	110	009	014	3 12	
928—929	„ „ 15th „ „	1 05	66	07	·101	·018	016	3 94	
				*Khoh river					
740—741	Khoh river, 1st Aug 1906	1 24	·77	·07	084	021	·008	1 07	
760—761	„ „ 8th „ „	·18	30	06	·074	019	007	91	

* REMARKS.—1st Aug. 1906 Sample taken 200 ft. above junction of Khoh and Sukhras rivers
Gauge where sample was taken 4 5
Full flood gauge . . 5 2
Duration of flood, 2½ hours.
8th „ „ Sample taken 1,000 ft above the junction of Khoh and Sakras rivers
Gauge where sample was taken 4 8.
Full flood gauge . . . 6 0.
Duration of flood, 7½ hours.

Statement showing chemical composition of samples of silt obtained from ten Indian Rivers—concld.

Laboratory No.	Description	Silt grm. per 100 c. c.	Silt lbs. per c. ft.	Organic Nitrogen.	Total Phosphoric acid.	Available Phosphoric acid.	Available Potash.	Calcium carbonate.	
				GAULA NADI (Naini Tal).					
699—700	Gaula Nadi, 19th July 1906 .	2·31	1·40	·07	·147	·025	·014	1·60	Water flow was 5½ ft. high
725—726	„ „ 29th „ „ .	·09	·62	·01	·079	·004	·009	3·39	
727—728	„ „ 2nd Aug. „ .	2·06	1·29	·03	·103	·001	·013	3·27	Flood 18½ ft high at 8 P. M., and remained flooding up to 2 A. M.
734—735	„ „ 3rd „ „ .	·05	·39	·05	·112	·016	013	5·76	
742—743	„ „ 6th „ „ .	1·10	03	·01	·091	·004	008	4·34	Flood 12½ ft. High at 7 A. M.
751—755	„ „ 19th „ „ .	·27	·17	·03	032	·005	·009	5·00	Flood 5½ ft and lasted one hour
810—820	„ „ 11th Sept „ .	·80	·50	08	·101	·002	007	3·16	Height of flood 8 ft.
821—822	„ „ 15th „ „ .	·22	14	01	·086	011	·009	2·01	
				BETWA RIVER.					
815—816	Betwa river, 14th Sept 1906 .	·08	·05	·13	Not determined—sample too small.			1·21	
46—847	„ „ 28th „ „ .	·14	·09	·12	·116	Not determined—sample too small.		3·55	
				DHASSAN RIVER.					
778—779	Dhassan river, 25th July 1906	·1	06	11	066	Not determined—sample too small		·60	Flood lasted 8 hours, gauge 5·8 9

APPENDIX G.

PAPERS ON THE UTILIZATION OF THE GRANT MADE BY THE BRITISH COTTON GROWING ASSOCIATION FOR THE IMPROVEMENT OF INDIAN COTTON.

Letter No. 121—37, dated the 23rd January 1907, from the Under-Secretary to the Government of India, Department of Revenue and Agriculture, to the Inspector General of Agriculture in India.

I am directed to forward a copy of a despatch received from His Majesty's Secretary of State for India, No. 181 (Revenue), dated the 14th September 1906, with enclosure, relating to the utilization of the funds placed at the disposal of the Government of India by the British Cotton Growing Association for the improvement of Indian cotton growing, together with a copy of a despatch* addressed to the Secretary of State by the Government of Bombay regarding the scheme for the disposal of this year's crop of Egyptian cotton in Sind.

* No 3, dated the 3rd November 1906

2. It appears to the Government of India that the system adopted in Sind has considerable merits and I am to request that you will favour them with your opinion on the sheeme in connection with the disposal of cotton grown with the aid of funds furnished by the association after consultation with the Board of Agriculture at their meeting in February.

INDIA OFFICE, LONDON.
14th September 1906.

Revenue No. 181.

To His Excellency the Right Honourable the Governor-General of India in Council.

My Lord,

With reference to the letter from your Secretary in the Revenue and Agriculture Department, No. 158, dated the 15th July 1906, and its enclosures, I forward copy of a letter from the British Cotton Growing Association, dated the 22nd August, in which they make suggestions for the utilization of part of the funds, now at your disposal, for the improvement of Indian cotton growing, in guaranteeing to planters who undertake the cultivation of better class cottons a full price for their produce during the earlier years of the undertaking.

2. I request that I may be informed of your views on this suggestion; and also that you will take into consideration the objection raised by the Association to the scheme which has been put forward with this object in the case of the Punjab.

3. The sum of £ 1,233-6-8 has been paid in by the Association, being the equivalent of the sum of Rs. 18,500 asked for in your Revenue and Agriculture Secretary's letter above quoted, and it will be credited in the account current to be sent to India for the month of August.

I have, etc.,
JOHN MORLEY.

The British Cotton Growing Association.

EQUITABLE BUILDINGS,
13, ST. ANN STREET,
MANCHESTER,
August 22nd, 1906.

The Under-Secretary of State, India Office, London, S. W.

SIR,

I beg to acknowledge receipt of your letter of August 13th, R. and S. 2197, which was placed before the Indian Committee of this Association yesterday,

and in accordance with their instructions the sum of £1,233-6-8 will be placed to the credit of the Secretary of State in Council at the Bank of England.

2. The proposals generally seem to have been carefully thought out, and should be most useful in promoting the growth of better classes of cotton, and I am instructed to thank you for the very full information forwarded with your letter. My Committee, however, wish me to call attention to paragraph 8 *Punjab*. It is certainly absolutely essential that a market should be found for any cotton produced from better classes of seed, but at the same time it seems to the Committee that the cost of the proposed arrangement, namely, £ 500, is rather excessive, and they would be greatly obliged if you could ask the Inspector-General of Agriculture to look into this proposal again to see if some better and more economical plan could be adopted. In any case I trust that arrangements can be made for the planters to receive the full market value of their produce, as it is felt here that in the case of the arrangements made for the purchasing of the Egyptian cotton grown in Sind, native planters were not sufficiently protected. It is probable that if they had received the full prices which the state of the market justified, they would have been more encouraged to extend the growth of Egyptian cotton.

3. In connection with this point, there is not the slightest doubt that in order to establish the cultivation of better classes of cotton, which have been proved by experiment to be suitable for any particular district, it is essential, especially in the early stages, that the natives receive a satisfactory price for the cotton grown. In West Africa this Association entered into an arrangement with the local authorities to guarantee a fixed price for a period of three years, which arrangement has had most satisfactory results, and I would suggest for your consideration whether part of the funds placed at your disposal by this Association should not be devoted towards extending the growth of cotton by guaranteeing the planters full prices for their cotton. My Committee is afraid that if the matter is left in its initial stages to the ordinary commercial people, that the latter will not have sufficient foresight to see the advisability of giving the natives the highest price possible There is no doubt that in the long run any money that might be lost, either by the Association or by others, in paying high prices in the initial stages would be more than recovered at a later date by the establishment of systematic cultivation of better qualities of cotton. One can hardly expect ordinary commercial houses to look at things from this point of view, and I would respectfully suggest for your consideration the possibility of the local agricultural officials lending every assistance to the ryots to obtain full prices for their cotton where there is not sufficient local competition to enable them to obtain the proper market value.

I am, &c.,

A. ARTHUR HUTTON,

Vice-Chairman.

No. 3, dated Bombay Castle, the 3rd November 1906.

From—The Government of Bombay, Revenue Department,

To—His Majesty's Secretary of State for India, London.

With reference to our telegrams, dated the 11th, 14th and 18th instant, on the subject of the offer of the British Cotton Growing Association to purchase the produce of Egyptian cotton seed in Sind, we have the honour now to explain the considerations on which our views were based.

2. The British Cotton Growing Association observe that it is of vital importance in the earlier stages that the native cultivator should receive a good price for his cotton and that the arrangements made last year were not satisfactory. The measures adopted for the disposal of the crop of 1905 were described in the report of the Director of Agriculture, No. C. 44, dated the 19th May 1906, a copy of which was forwarded to you with our despatch No. 1, dated the 2nd June 1906. From this report we became aware that the results obtained from the cultivation of Egyptian cotton in Sind during the season

of 1905 fell somewhat short of the high expectations originally formed both as to yield and the price obtainable. The deficiency of outturn was apparently due, first to the unfavourable character of the season, and secondly, and perhaps more largely, to the very partial adoption by the Sindhi zamindar of the Egyptian methods of cultivation, which are far more expensive and laborious than the indigenous methods to which he is accustomed. The prices obtained were considerably lower than was hoped, but not lower than was reasonable under the special circumstances of the case. Egyptian cotton was a new commodity for the Sindhi zamindar to dispose of, and the formation of a market in which to dispose of at prices sufficiently favourable to encourage him to continue the experiment constituted, at the outset, a problem of no small difficulty. It was impossible for Government to buy up the whole crop and dispose of it in England, both because such a course would have been extremely unsatisfactory to cotton merchants doing business in India and because any departure from the well-established principle that Government should not enter into competition with the trade, would have been most undesirable. The efforts made to stimulate the Indian market failed to have any great effect, for there was no expert valuer on the spot to inform the cotton merchants of the true value of the product, and owing to the small quantity of the crop and the difficulties of collecting and marketing it, few of the large firms could be induced to make arrangements for purchase. That it was purchased in large quantities at all was due mainly to the enterprise of a single firm, who gave for it prices comparing not unsatisfactorily with the valuation reported by Mr. Fletcher, Deputy Director of Agriculture in this Presidency.

3. That the market would grow as the success of the experiment became assured and the zamindars learnt the value of their cotton we were confident. It was however apparent that the zamindars themselves could not combine to make a fair field for themselves, and that Government could with advantage intervene in order to bring buyers and sellers together, and accordingly the Director of Agriculture and the Commissioner in Sind were requested to consider what arrangements to that end could be devised in time to meet the requirements of the current season. The reports received from these officers contained the suggestions that the zamindars should be assisted to convey their cotton from their fields to a central spot, such as Mirpur Khas, where it should be ginned and that the ginned cotton should then either (*a*) be despatched by rail to the large markets at Bombay or Karachi for sale on behalf of the zamindars, or (*b*) be sold at public auction on their behalf at Mirpur Khas, the idea underlying this latter suggestion being that the larger exporting firms would find it worth while to send their agents to purchase, provided the cotton were collected in one place and put up for sale in large lots instead of being scattered in small and varying quantities in many villages. After careful consideration we have approved the adoption of the second alternative desiring to reduce to a minimum the interference of Government with the ordinary course of trade and have authorized the Commissioner in Sind to incur the necessary expenditure up to a limit of Rs. 5,000 and entertain the special temporary establishment which the scheme will require. The establishment has been entertained accordingly, and arrangements are now complete under which cotton which zamindars wish to sell will under the supervision of an officer of the Mukhtiarkar's grade be collected from the villages in sub-depôts and thence despatched to a main depôt at Mirpur Khas, where collections will periodically be put to public auction.

4. The offer of the British Cotton Growing Association to purchase all Egyptian cotton grown in Sind at 2*d.* per lb. of seed cotton or Rs. 10 per maund which was communicated to us in the letter from the Assistant Secretary, Revenue and Statistics Department, No. R. and S. 2632, dated 21st September 1906, received our very careful attention before we despatched our telegram of the 18th instant. It is an offer which leaves us in considerable uncertainty as to its exact meaning since it deals neither with the method nor the time of payment and omits to specify whether the price named is for seed cotton collected at Mirpur Khas or bought at the threshing floor. On examination of it we are moreover in doubt whether the price offered is appreciably better than that paid by Messrs. Ralli Brothers last year, which

worked out to 7½d. per lb. of lint for *abbasi*, on the basis of 26·2 per cent. of lint to seed; assuming that the zamindars themselves have to bear the cost of collection, the Association's offer amounts to no more than 7⅜rd per lb. of lint. Reports received from Sind show that competition for this season's crop is fairly brisk, and already some of the zamindars have sold at Rs. 12 per maund of seed cotton delivered at the threshing floor; signs of activity among purchasers are most encouraging, and it is not improbable that very little use will be made of the machinery which Government have provided for helping the zamindars to dispose of their crop for good prices.

5. The letter from the British Cotton Growing Association conveys the impression that they imperfectly apprehend the actual position and believe that the crop is or can be made to be, at the disposal of Government. The crop is of course the property of zamindars who can sell or not as they choose and who could not be bound by any undertaking which Government might enter into. But apart from that consideration, we should be indisposed to grant the Association a monopoly which we believe to be undesirable in view of the competition which is coming into play, a monopoly which might conceivably have a very prejudicial effect on the future local market and stand in the way of the utilization of Sind Egyptian cotton in the mills of this country.

6. Probably the competition on a large scale of the British Cotton Growing Association would exercise a very healthy effect over the sales in Sind, and bearing that in mind, we have in our telegram indicated the terms of the offer which it might be of some practical use to make Twelve rupees per maund of seed cotton for delivery at the threshing floor (all freight charges being borne by the Association) would, we are advised, be a fair offer to make, it being understood that the Association should appoint their own agent to purchase for them; Government could, of course, render them no assistance in the matter of selection or purchase, nor could they give any guarantee as to the quality of cotton offered for sale, nor as to the quantity to be obtained. In the very possible contingency of this suggestion failing to find favour with the Association they might be recommended to consider the advisability of being represented by an agent at the auction sales to be periodically held at Mirpur Khas.

APPENDIX H.

PAPERS ON THE IMPROVEMENT OF THE INDIAN SUGARCANE INDUSTRY.

Scheme for Provincial enquiry into the Sugarcane Industry by C. A. Barber, M. A., F. L. S., Government Botanist, Madras.

PART I.

Introduction.

The following note has been prepared with the object of suggesting suitable lines of enquiry into the present position of the sugarcane industry in the various parts of India. Such an enquiry will be necessary before it is possible to determine the directions in which improvement should take place in each province, and where any great extension is possible. There is no doubt that India has certain advantages over other sugar-producing countries, such as its cheap and abundant labour and its well-developed system of irrigation. But in spite of these advantages, the past history of attempts at improvement is not encouraging and presents an unusually long list of failures. One of the objects of this enquiry is to determine the causes of these failures and to guard against them in future.

The cultivation of the cane and the manufacture of sugar varies greatly from place to place. In some tracts it is of a very primitive nature, while in others the cultivation is most expensive and complicated. In most instances the manufacture leaves very much to be desired. The relative importance of the sections following will accordingly differ greatly in the various provinces. Where intensive cultivation and careful manufacture are not at present attempted, the note may be considered as suggestive of the directions in which improvements are to be sought.

2. *Climate.*—There can be no doubt that the general character of the climate has a very great influence on the cultivation of the sugarcane. Attention has been drawn to the fact that the hot, muggy weather during which the cane grows most rapidly is exactly that which the white man is least able to endure. Hot sun and moist air are the two essentials for the best results. The scant rainfall and dry air of India are, therefore, distinct disadvantages, but these have been largely overcome by irrigation facilities.

A general statement of the average temperature and rainfall and their distribution throughout the year will be of interest as throwing light upon the far greater yield obtained in some parts of India than in others, and the possibility of remunerative results being obtained in regions inhabited by European planters.

3. *The age of sugarcane cultivation in India.*—It appears to be highly probable that the cane first became a cultivated plant either in India towards the head of the Bay of Bengal, along the Malay Peninsula or in Cochin China, or in some of the islands of the Malay Archipelago. The cultivation in India is at any rate of great antiquity. A brief historical statement of the earliest references to cultivation would be of interest.

There are also cases where, owing to the spread of population or irrigation the cultivation is of comparatively recent introduction. Such instances will be of special interest in considering possible future extension.

4. *The extent and character of cultivation.*—What is the area under cultivation in each province? Has there been any marked increase or decrease during recent years? If so, to what cause can this be assigned?

It cannot be too strongly insisted on that, for any real progress to be made in the extension of sugarcane cultivation, it must be conducted with very great care. Such differences in yield as are to be noted in the various provinces cannot be explained by mere difference in climate, and are largely due to the class of cultivation practised.

A statement of the general character of the cultivation in each province will be of interest. In some parts, for instance, the cane is cultivated in isolated patches of an acre or more in surrounding paddy. In others cane takes its

place in a regular rotation of various dry or garden crops, being irrigated from wells or other local sources. Lastly, there are parts where irrigation is not or barely attempted, and hundreds or thousands of acres are under a low, bushy growth of inferior varieties. It will usually happen that the cultivation varies a good deal in different parts of one province. The relative importance of the different classes of cultivation might be briefly stated.

The origin of the soil, whether deltaic, alluvial or the result of the breaking down of sedimentary or volcanic rocks, may be specified, and its character, whether heavy clay, loamy or light and sandy, may be specified. Comparisons of such soils are not readily made on paper, and it would be a useful proceeding if samples of the chief sugarcane soils of each province were collected and placed before the next meeting of the Board of Agriculture, under the direction of the Imperial Agricultural Chemist.

5. *Varieties of cane grown.*—There is at present no satisfactory basis for the classification of canes. The close similarity of all the varieties botanically, and the known alteration of the same canes when moved from one part of the country to another in habit and size, renders the subject especially difficult. Shades of colour are not constant, and these even change during the growth of the cane itself. Lastly, it is generally conceded that the richness of the juice must be included in any system of cane classification.

This renders a statement of the varieties grown in any province difficult. But in each tract there are differences well known to the cultivators both in the field and at the mill. A summary statement of the varieties met with and their native names will be the first step towards a regular survey of the canes of India, which is, from many points of view, a desirable piece of work.

Attention should be paid to the following main classes :—

Wild canes, that is to say, such as do not yield *gur*, but are used in medicine or for fodder.

Reed or grass canes, such as have proved themselves capable of resisting disease when neglected, hardy, bushy or small-growing canes, of poor sugar content and as such not especially sought after by wild animals.

Hardy field canes of good quality. This is usually the best class of cane for India. They have hard rinds and rich juice, yield heavily, and are not much attacked by jackals and wild cats In many parts of the country they have, however, dwindled from lack of care, and are with difficulty distinguished from the previous class.

Canes for eating and jaggery canes. These have much juice, frequently of low sucrose content; they possess soft rinds, and are usually very delicate and liable to disease. They are great favourites for the production of jaggery or *gur*, but are not suited for the production of high grade sugars.

Giant canes. Generally of enormous size, but with poor juice. They are difficult to mill because of their thickness and have often to be split before crushing. The outturn from these canes is sometimes very great, and they would appear to be best suited to climates with comparatively heavy rainfall.

As to colour, the canes may be distinguished as the red canes, the ashy or dirty canes (greyish or brownish in tone), red striped canes (the red alternating with green or yellow), green striped canes where yellow and green alternate but with no red, and the various "white," yellow or green canes. The latter three are not distinguishable as a rule, but the prevailing colour should be noted.

Where a sugarcane classification has already been attempted, the details of such classification should be mentioned There is no doubt that certain points of difference are of systematic importance while others are not, and the experience of workers in this field will be of the greatest value, whether these characters are of chemical or botanical nature, or as to their behaviour in the field or at the mill.

It would add greatly to the interest of the proposed meeting at Cawnpore if a collection of canes was brought from each province and placed side by side for comparison. Such canes should in all cases be as fresh as possible, each single cane being carefully wrapped in paddy straw rope. There should be at least half a dozen canes of each kind, and each variety should be carefully labelled and packed in a gunny bag Care should also be taken to select average canes, and not exceptionally good ones.

It will be seen that the classification proposed for the purposes of the preliminary enquiry is neither botanical nor specific, but is regarded solely from the point of view of cultivation. The proposed preliminary grouping of canes may be imperfectly suited to the conditions of some provinces, which may demand a more detailed classification. A true botanical classification is, probably, a matter for a later stage of the enquiry.

6. *Recorded introduction of new varieties.*—The canes of many parts of India are of the poorest description. It is impossible now to determine where these canes came from, but they have probably been in the country for a very long time. It is certain that a constant interchange of varieties has been taking place ever since sugarcane was first cultivated. There are numerous traces of exotic canes in various parts of Bengal, Bombay and Madras, and detailed records exist of such introductions during the last hundred years. It would be well for these cases to be noted and at the same time to mention what changes have taken place in the character of the canes introduced. Some of them have evidently deteriorated greatly, while others have taken their places among the best canes of the country.

When we read of such results as 105 tons of stripped canes to the acre, as is recorded of the Rappoe in New South Wales, it is not unnatural to assume that such large yields are dependent on the kind of cane cultivated, and due attention is not always paid to the special conditions attending such abnormal crops. This has undoubtedly been the main reason for the various attempts at introducing foreign kinds. But the Indian climate has not been sufficiently considered, and past efforts have been more or less haphazard, on the chance of valuable results being obtained. There is no doubt that the introduction of exotic canes, methodically and persistently practised, with due regard to climatic conditions, is likely to lead to very valuable results, and a full statement of past experiments in this direction will be of value.

In the same way the export of known varieties to Java and other countries should be noted with, if possible, some remarks as to their ultimate fate.

7. *"Sports" and seedling canes.*—Allied to the introduction of new kinds of cane is the appearance, by sports or otherwise, of new canes in India itself.

The striped canes are known especially to lend themselves to the production of varieties of one colour. In the Godavari district of Madras, the ryots assert that if you plant a field with *Namalu* (a striped cane) it soon becomes half *Keli* (a green cane), and several new varieties have recently been obtained in this way at the Samalkota farm in the same district, differing markedly in the richness of their juice from the parents. While this "sporting" is rendered evident in the striped canes because of their colour, it probably also occurs in most canes grown, and it is quite possible that most varieties of the sugarcane have arisen in this way. Any instances known of such varieties arising locally should be carefully recorded. For some reason the fertility of the cane flowers or "arrow" is very low in India. Cases have, however, been recorded of fertile seed having been obtained and seedlings raised. Considering the immense importance which this line of work has attained in Java, the West Indies and some other countries, any information obtainable as to seedlings raised in India will be valuable, together with the probability of this method being feasible. It seems probable that the climate of the country is against any great development of this mode of raising new varieties.

8. *Other sources of sugar and spirit.*—Before proceeding to the detailed study of the sugarcane industry, it would be well if a summary were prepared of other sources of supply of sugar and spirit in the different provinces. Sugar is obtained from various palms, from the juices of trees such as the maple, from members of the grass tribe such as sorghum, and from roots such as beet, while spirit is obtained from the most diverse substances. The two chief plants other than sugarcane from which sugar is obtained in India are the date and the palmyra. Spirit is produced among other plants from the mahwa (*Bassia latifolia*). Considering the close connection between the sugar factory and the distillery, an enumeration of the sources of spirit should be included.

It will also be of interest if any experiments with beet and sorghum made in the past are recorded with the results obtained.

PART II.

Cultivation.

9. *Planting and reaping seasons.*—The planting and reaping seasons and the time during which the cane is in the ground should be specified. This will very largely depend on the climate and the irrigation facilities But the importance of reaping the canes at the correct time is perhaps hardly fully realised, and cannot be too strongly insisted on. The time during which the cane is in the ground varies from 6 to 18 months. This will obviously make a great difference in the yield obtained, and the enormous crops sometimes reported from different parts of the world largely depend on the possibility of keeping the cane growing for a long period without ripening off.

At the same time certain canes ripen more quickly than others, and it is unwise to try and grow a cane which ripens slowly in a place where irrigation is deficient. A knowledge of the ordinary seasons of cane growth is necessary before any attempts are made at introducing new and improved varieties.

It is usual to reap the canes in the earlier months of the year, this being the time when the air becomes dry and the rains cease. But in the Coimbatore district of the Madras Presidency, there are two distinct reaping and planting times—February and September. In other places the reaping times are determined by the labour required for other crops, and these and similar facts must be borne in mind when considering the possibility of any great extension in cultivation.

10. *Rotations and mixed cropping.*—The question of rotations is an important one. In many places the sugarcane alternates with wet paddy. This is especilly the case in the irrigated delta lands and, although at present perhaps unavoidable, may be regarded as essentially bad practice. This also applies to the few cases of continuous cane-planting on the same land, excepting where an annual overflow of silt-laden water serves to recuperate the soil.

A statement of the chief rotations in the different portions of the province will be of interest, especially such as include a leguminous crop in the series.

The practice of green-dressing, or planting a pulse crop and digging it in before cane planting, is usually considered very good practice, although its value probably differs considerably in heavy delta lands and clay soils from those of lighter character.

Mixed cropping or the growing of catch crops with the cane should be noted. The cane shoots are at first quite unable to cover the ground and a quick-growing crop of maize, tobacco, onions, or pulse is not infrequently taken off during the first two or three months after planting. In lighter soils, such as the volcanic soils of St. Kitts in the West Indies, it is considered very good practice to bury pigeon peas (*Cajanus indicus*), castor or sweet potatoes thus planted, before they are ripe, the ground being covered during the hot, dry months, and the canes receiving a useful manure when they most need it.

Lastly, the fringes or outskirts of cane fields or the bunds separating the different plots in irrigated land are not infrequently sown with tur (*Cajanus indicus*), hemp (*Hibiscus cannabinus*) or okras (*Hibiscus esculentus*). Are any such crops planted for the protection of the cane crops, such as *Sesbania ægyptiaca* or sorghum? It has been suggested that the latter plants may serve as a useful trap for the moth-borer where it is prevalent.

11. *Ratoons.*—After the canes have been cut, the stools or "roots" are not infrequently allowed to grow for a second year. This practice of ratooning is carried on for many years in some places. In India it appears to be unusual and unprofitable to ratoon for more than one year, but cases are on record where the cane field is thus treated for as many as twenty years. As the practice has many advantages, it will be well to consider its practicability in each cane tract. The canes ripen earlier and the joints are closer together, thus rendering ratoons particularly suitable for cane seed.

On the other hand, there are certain dangers in the practice which should be carefully considered. The prevailing Indian sugarcane disease, the red smut, appears to be much worse in ratoons than in plant canes. Not only is the outturn rendered doubtful, but fields thus diseased are the worst possible for seed purposes. Without doubt the spread of this deadly disease has been largely fostered by the practice of using ratoons for seed.

12. *Preparation of the land for planting.*—It is of prime importance in cane cultivation to bring the lands as soon as possible into what is known as "good heart." This cannot usually be done where the rotation is one with wet paddy, this forming one of the chief objections to this kind of cultivation. The various operations having this end in view may be conveniently divided into those before and after planting the cane sets, and those referred to here deal exclusively with the manner of working up the soil. The main object in the earlier operations is to thoroughly clear the land, to ærate it and to render its condition such that the manures already in the soil or subsequently applied to the land are readily available. The later operations are largely intended to keep down weeds and to keep the surface tilth for the better conservation of moisture.

The actual mode of tillage, with the implements used, such as crowbarring, ploughing, the absence of either, puddling before ploughing and other methods in different kinds of land in each province should be mentioned.

Bare fallow is perhaps of special value in heavy lands and where the tillage is deep. In crowbarring the clods are large and heavy and need much weathering. Opinions as to the value of this practice in India are somewhat conflicting and the local practice will be of special interest.

Sheep and cattle folding, spreading compost, village manure or other substances before tillage may conveniently be considered here.

The after cultivation may be discussed at a later stage.

13. *Planting.*—There are a number of points to be considered under this head, and the whole growth of the cane will depend very largely on the manner in which planting is done. The matter is therefore of considerable interest, and fairly full details should be given as to the practice in vogue in different places.

14. *The source from which the seed is obtained.*—It is usual in most places, while the crop is being removed, to separate the "tops," consisting of the two uppermost joints with little or no sugar in them, and keep them for planting the next season's crop.

In some places this is done from first year's canes, in others ratoons are selected for the purpose. The latter practice has been referred to already and has this advantage that the crop can generally be planted earlier than otherwise.

Bringing sets from a distance has been frequently referred to in cane literature. This practice is carried out in Java on a very large scale, special plantations being set apart in the higher regions as nurseries for the fields in the plains. The object in Java is mainly to prevent the ravages of *sereh*, a destructive cane disease, and ratoons are never used for seed. In the Godavari district sets for planting in the delta lands are frequently brought from the uplands, where the soil is lighter and the prevailing disease is less severe. The removal of canes from one part of the country to another cannot be generally adopted because of the expense, but a considerable mass of information is available as to the effect of this practice upon the character of the growth and especially on the richness of the juice. It would be useful if information on these heads in various cane tracts were recorded.

When the canes for seed are allowed to stand in the field for some months after the bulk of crop has been reaped, the practice should be recorded. These canes are called "Standovers" in the East Indies where the practice is not uncommon.

15. *The part of the cane used for planting.*—This again varies a good deal. There is no doubt that the practice of using the upper part of the cane for planting and the lower for milling is sound. But in many parts of the country the whole cane is cut up into sets and planted, only the lower rooting joints being rejected. The method should probably vary a good deal with the kind of cane grown, for, from experiments conducted at the Samalkota farm, it has been demonstrated that in certain canes, while the tops produce a good even stand of canes, beds planted from the whole cane cut up leave many gaps. In other varieties planted at the same time and on similar land, any part of the cane can be used with impunity. The laying of the whole cane in shallow trenches is reported from certain districts.

The mode of preparing the sets and the part of the cane used is of some importance when considering the future action of Government farms in

distributing seed of new and improved kinds of cane. If tops alone are to be used, the rate of introduction of the new kinds will be extremely slow.

16. *The actual preparation of the sets for planting.*—The number of joints in a set should be specified and the general mode of preparation. It is the practice in careful cultivation to pickle the sets in various solutions before planting. This is usually done on account of definite diseases which may be passed from parent to child. The indiscriminate soaking of sets in various solutions is therefore not necessary, but any action will depend on the disease to be guarded against. The following cases may be mentioned in illustration of this.

Where white ants are a serious menace to the newly planted cane, various infusions are recommended to render the sets unpalatable. The same has been done with regard to jackals which dig up the pieces at night immediately after planting. Where the moth-borer is a serious pest, the soaking of the canes in strong lime solution has been found useful. Where acari or mites (causing one of the diseases called "rust") are abundant, corbolic acid is said to be a useful preventive. Where, as in the West Indies and Java, the sets are attacked by certain fungus diseases, the use of coppor sulphate and tar is recommended. Any instances of such action in the provinces will be worth recording.

17. *The number of sets per acre.*—This is a matter requiring some attention, as without doubt improvements may be made in some cases. The rate of planting may vary anywhere between 4,000 and 50,000 per acre. It is obvious that this large number not only increases the cost of cultivation to a considerable extent and renders the introduction of new varieties more difficult, but the chances of carefully selecting good seed are greatly diminished, if not rendered impossible. As a rule the tillering power of canes in India is far inferior to that in tropical islands where irrigation is unknown. More plants are, therefore, required to the acre. At the same time the planting of a very large number of sets with the object of "somehow" getting a crop tends to carelessness in the early treatment of the canes, and a bad start is hardly ever fully recovered during the subsequent growth.

18. *The mode of planting.*—Planting is done in pits or trenches, in rows or broadcast, in dry ground or in puddle. It depends greatly on the nature of the soil and its capacity for retaining moisture and on the weather at the time of planting. The cane usually takes about one year to mature, and this regulates the time of planting. Reaping and planting must usually proceed at about the same time of year. This, in most parts is in the hot dry months, and as a natural consequence the depth at which the sets are placed is a somewhat important matter. The young plant, with the small amount of nutrition available in the set, is very delicate, and specially liable to withering, if not planted deep enough. On the other hand, deep-planting cannot be successfully introduced in most cases, in heavy land because the power of germination is impaired, and in lighter soils because of the white ants. Considering the great mortality in newly planted can fields, the exact depth should be carefully gauged.

Broadcasting is not infrequent, but it is obvious that the proper distances of the plants from one another cannot thus be well regulated and also that all the subsequent operations of weeding, hoeing and wrapping are rendered more difficult and costly. Planting in pits is not usual in India. It is of special significance in rain-fed plantations where it is important to conserve the rain for as long a period as possible. The distance of the rows apart is worthy of consideration but will depend to some extent on the number of sets per acre. The best practice aims at placing the canes as equidistant as possible.

19. *Supplying vacancies.*—It is very important in planting a cane field to obtain a perfectly even stand, where each plant has the maximum of surrounding earth to draw upon for its nutrition. This is not obtainable by the excessive planting of the native. The more careful cultivators recognize this fact and in many parts of the country special arrangements are made for supplying any vacancies detected when the germination has taken place.

In some cases a supply of extra sets is kept in pits, and these are planted when the vacancies declare themselves. In other cases small strips or

outskirts are thickly planted and the young plants are removed from these to fill the gaps. The latter practice appears to be preferable. The time elapsing between the general planting and the date of supplying should be carefully noted and recorded. It appears that if supplying is delayed too long, the plants thus added have not time to establish themselves before they are overshadowed, and in fact never come up with the main crop. In the neighbourhood of Coimbatore the extra plants are added within a month or at latest six weeks from the time of planting.

The matter of keeping cut canes for some time before planting invites attention, and the local practices are worth recording. This "hatching," as it has been called is necessary sometimes, both in the fields of the cultivators when the land is not quite ready and on Government farms where canes are received from a distance. It would be a useful thing to determine how long they can be kept after cutting without losing their vitality and what are the best methods for thus keeping them in the different provinces.

20. *Seed-bed and nursery.*—In some districts, as in that of Ganjam in Madras, it is the custom to lay the sets thickly in seed-beds (much like paddy seed-beds) and, later on to transplant them to the fields. This curious practice has probably arisen because of the short period during which water is available or because of doubt as to when it will arrive in the channels. The practice is of especial importance where water is abundant for the greater part of the year, but cannot be obtained just when the canes must be cut and the sets planted for the succeeding crop.

The seed-bed may be made to serve for ten to fifteen times its area in the field. It may be placed under a well, and as a matter of fact, is usually located near the village on the specially rich fields to be met with in such localities. Details of any such system in India will be of interest.

21. *Stool planting.*—The old roots of the cane have usually to be removed at some expense after reaping, in order to prepare the land for the next crop in the series. The splitting and planting of such roots or stools entails comparatively little additional expense and has its advantages. The fields thus planted need no supplies and are perfectly filled when planted at the rate of 5,000 to the acre. The resulting canes appear to be very healthy and assume a character midway between plant canes and ratoons. It will be interesting to know if this system has been adopted anywhere by the local cultivators. It is of special usefulness when it is desired to multiply rapidly any particularly valuable variety for distribution. The crop raised appears to be perfectly healthy and in this respect shows a marked contrast to ratoons.

It may be pointed out that, both in this system and in the planting from nursery beds, a means may be found of combating the white ants which will less readily attack living plants but devour the cane sets with the greatest avidity.

22. *Irrigation and drainage*—It is well, before considering the watering of the cane, to refer again to the great difference between the climate of India and that of most sugar-growing countries. In India the bulk of the rain falls during some four months, and the severe drought following renders irrigation a necessity. In most other countries where the cane is grown, irrigation is unknown and a well distributed rainfall brings the cane to perfection.

The great mass of rain falling during the wet period in India emphasises the importance of thorough drainage of the land, and the subsequent drought brings into special prominence the after-cultivation of the soil for the purpose of retaining the moisture.

For large crops and intensive cultivation irrigation may be considered a necessity in India. But it varies much in character, and a statement of the different means adopted will be of interest.

In certain tracts the crop is purely rain-fed and the resulting crops are meagre; in other places advantage is taken of river and spring channels; wells are used over large areas where the subsoil water is easily accessible; excellent canes are grown under tanks; but for the production of sugarcane on a large scale irrigation canals are usually needed.

A statement of the season of the year during which the water is available will be of interest, for it should be possible in many places to supplement

the natural supply by pumping the sub-soil water with the aid of oil-engines. Undoubtedly there are many areas where the sub-soil water could be thus made use of, but where the expense of lifting the water by the native methods is too great.

In certain parts of India canes are grown which seem able to endure prolonged submersion. These are probably of little value from a sugar-making point of view, but the fact should be noted, as it is of interest, and enquiries on the subject are frequent.

23. *Cultivation.*—The after-cultivation of the cane fields has for its object the destruction of weeds, the retention of soil moisture and the protection of soil bacteria.

It is usually of short duration, for the canes quickly cover the ground and form a mulch of decaying leaves which answers these purposes. Where the cane has once covered the ground, it quickly becomes impossible to enter the fields. Where however "wrapping" is done, cultivation may continue throughout the life of the plants. Generally speaking, it is of advantage to the growth of the canes to continue the cultivation as long as possible, but as to whether it pays beyond a certain point remains to be decided.

A statement of the number of hoeings and weedings considered necessary in different places should be made, together with the implements used. The two operations mentioned may, for the purposes of this note, be separately considered, that of weeding being much deeper and more thorough, while the chief object of hoeing is to break up the cake on the surface after rain or irrigation and thus prevent undue evaporation.

The use of improved cultivators should certainly receive very careful attention and any cases of their successful introduction into India might be noted, as probably of far greater efficiency and economy than the current native methods.

Native expedients for the prevention of evaporation, such as laying a mulch of grass on the land, should be carefully noted, as well as any other matters connected with the use of water and its retention in the soil, although this should if possible be considered under the previous heading.

24. *Manuring.*—Next to the preparation of the land and the supply of water, manuring is the most important operation in the intensive cultivation of the sugarcane. Perhaps in no respect does the practice of the country vary more.

The manuring before planting has been mentioned under the preparation of the land and may be conveniently considered there, but, inasmuch as it has an influence on the later applications, it will be necessary to refer to it here as well in any carefully considered system.

The two materials regarded as essential in the most advanced sugar-growing countries are a good supply of well-rotted cattle manure and artificial fertilisers. Neither of these sources of manuring is available in the desired quantity in India at present The existing practices will, therefore, form a specially interesting subject for study and the possibility of their improvement a useful field for experiment. A statement of the results of experiments thus far made will be of value. It is needless to point out that artificial manures are of little value where the land is not in good condition, and this is specially applicable to heavy delta lands.

Various oil-cakes are used in different parts of the country, and the advisability of combining the growth of oil-yielding seeds with sugarcane is obvious A statement of the available supply of oil-cake in the different sugarcane tracts, its cost and comparative richness in nitrogen, should be prepared.

The time and mode of application of the manures should be studied. While most artificial fertilisers may be applied as soon as growth is established, the addition of nitrogenous manures should probably occur later. The practice in the Godavari delta is to apply oil-cake when the canes are four months old and there is an abundant supply of water in the canals.

It will be useful to consider here the practice of burning the trash or dead leaves after cutting the canes. This is frequently done, even where this material is not used for boiling the juice. When we consider that every ounce

of this valuable material is dug into the soil in the West Indies, it will be interesting to know if this practice is ever adopted in India.

The application of green-dressing after planting has already been considered. In many parts considerable sums of money are spent in bringing cart-loads of wild indigo (*Tephrosia purpurea*) and laying it at the roots of cane. Instances of this practice with wild indigo or other plants might be mentioned here.

Curious local superstitions are frequently met with regarding the cultivation of Indian crops These should be noted wherever possible. With regard to the application of manure to cane fields, cattle manure not well rotted is said to increase the quantity of treacle in the *gur*, while the addition of nim-cake is said to make the jaggery bitter. These local superstitions should be investigated if only to expose their fallacy. But more often there is some grain of truth which should be carefully sought for.

A brief statement should be appended as to what results of value have been definitely obtained by the many manurial experiments with sugarcane conducted in the country by agricultural departments.

25. *Treatment of the canes during growth.*—This will vary a good deal in different parts, in most places nothing whatever being done to the canes themselves. Wherever any special treatment is resorted to the fact should be mentioned.

Trashing, or the stripping of the canes of their old leaves, is supposed to let in light and air and to quicken the ripening of the canes. It is of doubtful advantage, excepting in moist, waterlogged situations. It is thought to render the canes more liable to diseases and undoubtedly exposes them to the attacks of wild animals.

Wrapping or tying the old leaves round the cane and to one another probably delays ripening, but also protects the canes from sunburn and cracking. The attacks of wild animals are diminished, and the canes are supported and prevented from lodging. The use of bamboos is perhaps advisable in heavy crops, and is rendered possible by wrapping the older leaves being tied to one another and to a central bamboo. This operation, while most useful in places where sudden wind storms arise, is costly and is perhaps sometimes carried to an extreme. As many as 5,000 bamboos per acre are not infrequently used in the Godavari district. Some modification of the practice will probably be found useful in most cane-growing areas, whether for straightening the cane and rendering it easier to manipulate, for protection or for support. Local modifications of the practice will, therefore, be of general interest.

The protection of the canes from jackals, although probably belonging to the next section, may be conveniently considered here. The matter is of considerable importance, and a careful study should be made of the native methods of dealing with this and kindred pests.

Many kinds of cane, in themselves valuable, are out of the question for general cultivation because of their liability to the attacks of jackals, pigs and wild cats. The first essential from this point of view in a field-cane is the possession of a hard rind. Wrapping has been referred to as a useful protection. In some places the mud is splashed from the irrigation channels over the lower leaves, which renders the canes distasteful to the jackals Fencing of various kinds, sometimes at great cost, is resorted to keep down the pest, but once the jackals get inside, it rather tends to aggravate the evil. Traps of various kinds are used. Perhaps the best form is a simple pan of jaggery water of which they are excessively fond placed near their regular run. The jackals will come in numbers to this and may be easily killed. The usual beating of drums in cane fields towards harvest time is less useful than generally supposed One of the greatest advantages of wrapping the canes is that you can at once detect the presence or ravages of animals by looking down the lines. Lastly, the planting of harder kinds outside the fields is sometimes resorted to with very doubtful results. The local practices in such matters frequently affords valuable hints as to ultimate successful treatment, and should be carefully recorded.

26. *Treatment of the fields preparatory to reaping the canes.*—Before cutting the canes, it is not unusual among the native cultivators to irrigate

profusely in order to increase the quntity of jaggery or *gur*. In other cases, where the water is deficient and the canes are judged to be ready for harvesting, they are allowed to stand in the field for a considerable time without watering.

Any facts throwing light on these practices will be of use. It is thought by some that before reaping, all water should be rigidly cut off so as to increase the richness of the juice and decrease the cost of fuel. The local practice among the native cultivators or in connection with European mills would be worth recording.

27. *Disease phenomena*.—These are of special importance in the sugarcane because of the comparatively great cost of its cultivation. The mature cane may be likened to a fruit It is filled with rich, sweet juice of a kind eagerly sought after by all the animal kingdom, while many fungi of feeble power of parasitism multiply rapidly in solutions of cane juice. Destruction thus frequently occurs at the end of the season and after all the expenses have been incurred with the prospect of an abundant harvest.

Of the numerous pests and diseases to which the sugarcane is liable, perhaps the most serious in India are the red smut, white ants, moth-borer and jackals. Many other diseases of wide occurrence become locally important, and lists of the chief ones in the different sugarcane tracts with their native names will be of interest. Such diseases and pests may be roughly classified as follows.

28. *Diseases affecting the sets after planting*.—Such is the "pine-apple" disease of Java and the West Indies, caused by the inroads of a fungus, where the sets acquire a distinct smell of the fruit named and fail to germinate. White ants frequently destroy the sets in lighter soils before they have time to germinate. Jackals collect in packs at night and dig up the newly planted pieces of cane. While sets taken from plants heavily attacked by red smut often fail to grow at all.

29. *Diseases affecting the whole plant*.—Foremost among these are the various forms of arrested growth. It is not always easy to determine their cause. The most deadly cane disease of modern times, the *sereh* of Java belongs to this class and there is some ground for believing that it occurs sporadically in India. The whole plant assumes the character of a bush of lemon-grass (*Andropogon schœnanthus*) and no cane is formed even after a year's growth. Sometimes one or two canes are formed, while the rest of the plant grows like a tuft of grass. A similar from of growth has been attributed in the West Indies to a definite mushroom growing on the cane roots. Another disease is the black smut (*Ustilago sacchari*) where the whole end of the shoot becomes a black powdery mass. And, lastly, the moth-borer eats the young apices, causing each in turn to die and the whole plant to assume a stunted, withered appearance

30. *Diseases confined to the underground parts of cane plants*.—Besides those mentioned in the last paragraph, numerous grubs are to be found attacking the roots and underground stems of the cane. These usually belong to various classes of beetles. White ants are of course specially destructive in this part of the cane. Different species of flowering plants attach their roots to those of the cane and absorb their nutriment from these (such are *Striga* and similar *scrophulariaceæ*.)

31. *Diseases affecting the stems*.—These are perhaps most serious. The red smut is distributed throughout the tropics and is perhaps a peculiarly Indian disease, occurring disastrously wherever the land is insufficiently drained. Borers in the cane do great damage, not only causing the canes to break up but affording an easy entrance to other enemies, notably the fungus pests. Mealy bugs can by no means be neglected, although their presence is connected rather with the spoiling of the juice in milling. Gumming is possibly present, but has not as yet forced itself on our attention in this country. Finally, jackals are universally feared and should everywhere be guarded against.

32. *Diseases affecting the leaves*.—In numbers the leaf diseases of the cane exceed all the rest put together. Numerous fungi are found causing blotches, rotting or withering. Insects of the most various orders are to be found attacking the leaves by piercing or sucking or wholesale eating. Rusts caused by mites are also by no means uncommon.

Some of these diseases are comparatively harmless. Others are the direct result of careless cultivation. But there are some which are difficult to deal with, and these should receive the greatest attention in the selection of the kinds of cane grown. There is little doubt that, while no cane can be considered immune from disease, different kinds vary greatly in their liability to attack. Care should, therefore, be taken in fresh introductions that no cane should be brought into a climate unsuited to it or from a region permeated by disease.

33. *Reaping. Time of cutting the canes.*—No general rule can be laid down as to the correct time at which the canes should be cut. It is largely a matter of expert knowledge. Most native growers know pretty well when the canes are ready for the mill and there are tests which can be readily applied by anyone having a knowledge of canes in the field.

A statement of the local knowledge of cane-ripening would be interesting and how far this is utilised and how far neglected and for what reasons.

The exact date of reaping is largely influenced by local superstitions and the labour available. Sugercane is, in many places, a minor crop and the ryots are frequently busy in other directions at harvest time. In places where it is the main crop, on the other hand, the labour is often insufficient. The milling power of the district is also sometimes inadequate to deal with the crop to the best advantage.

The cutting of canes at the wrong time is, by no means, a fault peculiar to native cultivators. It is perhaps one of the most important matters connected with the economical working of a large factory that the machinery should be kept in continuous working and that the reaping season should be spread over as long a period as possible. A carefully thought out system of planting may get over the difficulty to a certain extent but not altogether. Of necessity some of the canes are cut before they are fully ripe, while others are left for some time after they have reached their optimum. This is a matter for very careful consideration in framing estimates of the outturn. The adjustment of field and factory is a problem of some difficulty, and this perhaps accounts for the fact that excellence of manufacture and first class cultivation are so rarely combined in sugar-growing countries.

34. *Deterioration after cutting.*—After the canes are cut they rapidly deteriorate. This is caused by change from cane sugar to grape sugar, usually called "inversion." The distance of the canes from the mills thus becomes a matter of importance.

Delay in milling the canes is of comparatively little moment in the manufacture of jaggery, but it is of much more importance in sugar-making, and especially when we have to deal with a large steam plant. There are obvious difficulties in getting the canes cut on the exact date suited to the mill, and this is more particularly the case where cultivation and manufacture are in different hands. It is by no means unusual for canes to lie in the yard for days before they are dealt with. The probability of this delay and deterioration should be carefully considered when entering into calculations for any large new undertaking.

We should naturally suppose that this inversion in the cane after cutting would be greater in the hot Indian climate than elsewhere. But this has not been proved, and any facts bearing on the subject would be of interest.

35. *Mode of cutting the canes.*—It is important that the canes should be cut as low down as possible, if anything a little below the ground. Is this attended to? It is not likely that any cane-cutting machine will succeed, partly because of intrinsic difficulties and also because of the great weight of the material to be dealt with. If any experiments have been made in this direction they should be mentioned.

Where wrapping is in vogue, cutting the canes is comparatively easy; they are clean and straight and very easy to pass through the mill. The removal of the leaves used in wrapping is however an additional operation. Where the canes are allowed to grow naturally, it is not uncommon in a good field for two cuttings to be necessary, the first one about three feet from the ground and then at the base. The tops are removed either before or after reaping. The local practice will vary with the size of the plants and the denseness or growth, and should be stated.

36. *Yield per acre in canes.*—This is not usually calculated by native cultivators. But there are numerous "crop experiments" recorded from which some idea can be obtained for each district. This is an important item in the profit and loss account, especially where improved mills are erected, and information on the point is needed. The weight should be recorded in pounds.

PART III.

Manufacture.

Manufacture of jaggery or gur.—This is the main form in which the produce of the cane fields is placed upon the Indian market, and it will be convenient to treat it separately. Jaggary is usually stated by manufacturers to be unsuited for economical sugar-making, and the markets for the two substances are to all intents and purposes distinct.

A general account should be given of the methods in vogue among the native jaggery makers, and in suggesting improvements in its manufacture, it is advisable to consider the effect of these upon the price paid for the jaggery in the local market.

What mills are used? Have there been any recent improvements which have been largely adopted? A statement of the expression obtained from various mills should be given, but note should be taken of the fact that this will vary with the kind of cane and the mode of removal of the "tops."

In describing the treatment of the juice before boiling, mention should be made of the kind of pots used and their distribution, and the time elapsing between crushing and boiling. Is the juice strained at the mill or when it is poured in to the pans? Are colloting pans used or are the pots allowed to stand until there is sufficient juice to fill the pan? Is the collecting pan heated?

What pans are used? Are they single or in batteries and how are they heated? A statement of the fuel and its preparation would be of interest. In most regions it is found that the megass or residue from the mill and the trash or dead leaves are sufficient for the boiling of the juice. A start has sometimes to be made with other fuel. How far do these substances suffice for the boiling? It is obvious that this will depend on the relative quantity of juice and fibre in the cane. There can be little doubt that such light material is eminently suitable for the rapid boiling and shallow open pans. Is any wood used? Is the whole of the trash used up? This is an important question because of the value of this substance as manure.

Is the scum removed, and if so, what is done with it? Are there any native methods of clearing the juice by the addition of foreign substances?

To what extent is liming carried, firstly in treating the pots used for holding the juice, and, secondly, in preventing inversion in boiling? Is this liming fully done? Usually it is very incomplete because it detracts from the value of the jaggery in the local market. At the same time incomplete liming is the main cause of the unsuitability of *gur* for refining purposes.

What method is adopted for marking the correct point at which boiling should cease? Are cooling pans used? Into what form of receptacle is the boiled mass thrown and what is the resulting form as placed upon the market? Are any processes known for preserving the jaggery, or has it to be sold at once?

What is the average price obtained for good *gur*? There are fluctuations of some magnitude in the bazaar prices, dependent on the difficulty in keeping, on local festivals and so forth. A consideration of these largely influences the native practice and calculations and sometimes makes considerable difference in the profits obtained. Is the *gur* manufactured sufficient for the local demand, and if in excess or defect what local movements are there of this substance? Is *gur* made for the foreign market, and if so, are any special precautions taken in its manufacture? Lastly, what are the relations between jaggery made from the sugarcane and that obtained from other sources?

38. *Profit and loss on sugarcane cultivation.*—A brief statement of the cost of sugarcane cultivation in different parts of the province should be made and the average profits obtained by the cultivator.

Such statements have frequently been drawn up, but, for various reasons, they are not of much value. One of most weight is that it is almost impossible to state the real value of the labour employed. A special account should therefore be drawn up as to the usual best practice of the district, from the preparation of the land and the purchase of the seed to the placing of the finished product on the market. And where the cane roots have to be removed to prepare the ground for the next crop, this item of expense should be included in the account. It is well known locally how many men are needed for each and every operation. This should be recorded and their pay calculated at the current rate for that class of work. The outturn should similarly be calculated from a good average crop of the district. Thus only can we form an idea of the real cost of cultivation and the profits derived therefrom. It is certain that if any great extension or improvement were to take place, the labour would have to be paid for in this manner.

The sugarcane industry is usually considered to be one of the most profitable in India, and in many places it is regarded as a sign of increasing wealth for a ryot to embark on its cultivation. But the statements of profit and loss available vary in the most extraordinary manner, even in the same locality, from a dead loss in some parts of the country to a clear profit of several hundreds of rupees per acre in others. It would be well to insist on some common basis of valuation such as that mentioned above.

39. *Character and richness of the juice.*—It is frequently asserted in the "trade" that for sugar-making the native jaggery is of insufficient purity to ensure profitable working, that obtained from palms being in many ways preferable to that of the cane. This is, of course, partly due to the character of the cane grown. Varieties, which will satisfy native demands, are not the best for sugar-making. The native jaggery canes have frequently much juice of inferior sucrose content.

It becomes necessary, therefore, for analyses to be made of the existing local canes in different parts. This has already been done to a considerable extent, although the analyses are not always comparable because of differences in ripeness at the time of crushing. Existing analyses should be carefully collected. A general idea of the richness of the juice of canes in the various provinces can thus be obtained.

The known inferiority in the canes of certain tracts may be due to inherent poverty, to the climate or soil or to their recent introduction. These points should be held in view, and special attention paid to the alleged deterioration of introduced kinds. This again may be due to unsuitability of soil or climate for their growth and maturing or to the mere fact of the change. In the latter case a subsequent change for the better has been noted in certain canes.

In judging the comparative richness of the juice it would be well to fix upon some standard method of expressing the results. This has not hitherto been attended to, and the analyses of Indian canes are not easy to compare with those of the canes of most other countries, at any rate in terms readily understood by the majority of those interested in their cultivation.

The following are the main points of importance in the analysis of sugar-canes :—The quantity of juice in the cane and the percentage of sucrose and glucose, organic matter other than sugar and mineral matter, in this juice. A good cane in the West Indies will give juice with 81 per cent. of water, 17·5 per cent. of sucrose, not more than 5 per cent. of glucose and 1 per cent. of other organic substances and mineral matter. It has been ascertained that many of the Indian canes have juice as good in quality as this, but when they are not up to this standard the matter should receive very careful attention and the causes should be ascertained.

40. *Sugar-making.*—Besides the jaggery or *gur* referred to above, a great deal of what may be called sugar is also prepared by the natives of India. An examination of the processes of manufacture employed and character of the sugar produced should be made. But a detailed study of this part of the subject (which is extremely complicated) is perhaps of less importance, because in this field of work the native methods are generally wasteful and cannot compete with the improved machinery of other countries. The study of native methods of refining is perhaps more useful as indicating what demand there is for a better product than jaggery and whether any change is taking place in the

native taste. Every effort should be made to encourage such a change, for the production of sugar on a large scale for the local market in place of *gur* would pave the way for India to become a large sugar-producing country, and the question of export would naturally follow.

The nature of the native refined or partially refined sugars should be noted and the processes for getting rid of the molasses and other impurities. The subject is far too intricate to be fully dealt with in this summary, but some idea may be obtained as to the class of information required by a reference to the article on "Saccharum" in Watt's Dictionary of Economic Products and the publications of the Department of Agriculture in the United Provinces. In the latter it will be noted that the question of the profitableness of the various methods is exhaustively dealt with. This is an important aspect of the case, from the comparison of the improved plants there suggested with those of modern factories, it is quite possible that something between the two may be found most suitable in the present Indian conditions.

It will be well to note the relative price paid for *gur* and the different qualities of sugar in the local bazaar, and especially the trade movements of these products in the different parts of the province. There will be considerable difficulty in altering the local market to suit the purposes of the projectors of factories. The native cultivator will, obviously, dispose of his canes so as to obtain the best return for his labour. At present he has, in most parts of the country, a sufficient local market for his jaggery. He thoroughly understands its manufacture, has his mills and cattle and employs a large body of labour. Besides this, there is the known power of his conservatism, and, even in its absence, there is the inertia which naturally sets its face against any change. Very distinct advantages must, therefore, be offered at the beginning before any such change as that here suggested can take place, and the most complete system of agencies, will probably have to be planned to demonstrate the advantages of the new product and to ensure its punctual supply.

In considering the establishment of modern machinery in the country, it must be determined, as far as possible, what price the ryot will be willing to accept for his canes placed at the factory door, and what price the factor will be able to pay for the canes of the locality in order successfully to run his mill. At present there is little doubt that it is more profitable in the majority of cases for the cultivator to produce the time-honoured jaggery.

Factories with improved machinery have been built in India for many years Most of these have, it is true, failed, but it is chiefly in this direction that any real advance in the industry as a whole should be looked for. It will be of interest to record the past history of such experiments. Have any factories been started in the province? Which of these have ceased to exist and what has been the cause of thier failure? What factories are there at present working and what are the chances of success? How far is such success dependent on the making of spirit and what likelihood is there of successful companies being started without the aid of this allied industry? The whole question will be greatly complicated if it is found that any improvement in the sugarcane industry is inseparably connected with the manufacture of spirit.

A carefully compiled statement of the capital and working expenses of installations of different capacity is much needed. A brief description of the "plant" used in existing factories will be of interest together with the cost of erection and upkeep, the classes of sugar at present turned out, the capacity of the mills and the period during which they must be worked to ensure success, together with the amount of local material available.

Which of these factories deal directly with the cane and which are dependent on jaggery wholly or in part for their raw materials? Are there any or have there been any imports of raw sugar for refining from Java or Mauritius or other parts of India? What factories depend for their raw material on sources other than the sugarcane?

However long the period of cane-crushing may last, the mills cannot be kept fully working for a very long time. Are there any subsidiary industries which can be added to that of the production of raw or refined sugars?

A brief statement should be made of the state of the import trade Every year a large quantity of sugar is introduced into India from abroad, both from beet growing countries, such as Austria and Germany and from cane-growing countries, such as Mauritius and Java. The conditions regulating this import trade are not clearly understood, and it will be of interest to trace the course of such sugars to their place of consumption. It may be thus possible to determine how far they may be replaced by sugars refined by superior plants in the country itself. The cost of transport will play an important part in such considerations.

Much of this imported sugar is made from the beet. An interesting series of experiments has been made by the Government of India during recent years in the form of protecting the indigenous sugar industry from bounty-fed beet sugar, and the results of these experiments have been eagerly followed all over the country. Sufficeint time has perhaps elapsed for definite conclusions to be drawn. Hitherto considerable divergence of opinion has been evident. A brief statement showing the extent of importations of foreign sugars during recent years would be of interest. What influence was exercised upon this import by the restrictions placed on sugar favoured by bounties whether direct or indirect, and what has been the result of the total abolition of bounties by the Brussels Convention? One of the main difficulties regarding the installation of improved "plant" is uncertainty as to the future of the sugar market and any information throwing light on this difficult subject will be of the greatest value.

The question as to whether India is capable of entering the markets of the world and developing a large export trade in sugar cannot at present be entered upon. If we are unable to keep out foreign sugars coming from distant countries, it is idle to dream of competing with those sugars in the great European markets. On the other hand, India has definite advantages, such as its cheap labour and abundant irrigation, and it is not easy to understand the lack of success hitherto experienced.

It will greatly facilitate the discussion of the different classes of jaggery or *gur* and sugar, raw and refined, if samples are brought to the next meeting of the Agricultural Board. These should be as uniform as possible, and might be collected under instructions from the Imperial Agricultural Chemist. Such a collection should include sugars and jaggeries made from plants other than sugarcane and also samples of the imported sugars obtained from the local bazaars.

PART IV.

Improvements.

41. On considering the question carefully, it will probably be found that the lines, along which improvement is most likely to take place, will be different in the different provinces. It will be useful if the particular needs of each province are clearly set forth, so that the experience gained elsewhere may be rendered available.

Improvements may be effected in the following directions:—

Introduction of new varieties of canes, those of many tracts being admittedly inferior. This will require some care, but the dangers have already been sufficiently indicated.

More careful attention to the details of cultivation. Sugarcane is an expensive crop and readily responds to careful cultivation and manuring. The procedure in many parts is of the crudest description In most places alteration for the better means considerable outlay of capital, and the economy of intensive cultivation is doubtful in some of these.

Increased facilities for irrigation. This is a large question. Deficiency of water may be to some extent met by the raising of early ripening canes. There is no doubt that in many parts of India there are large stores of underground water at moderate depth which are at present out of the reach of the ryot, but may be raised at small cost by pumps worked by oil-engines.

Improvements in the manufacture of jaggery or *gur*. The purpose for which such jaggery is designed must be held in view. A taste for a better

product might be fostered, so that sugar could be prepared on a large scale for the local market and a profitable raw material be made available for refining.

The introduction of small plants for sugar-making. There are many difficulties in the way of the successful introduction of large up-to-date factories, and in many parts of the country a better result is likely to be obtained at present by the installation of numerous small factories dealing with 100 to 200 acres than of those requiring as many thousands to keep them profitably employed. The risk of failure would be proportionately diminished in the smaller concerns On the other hand, in some places, where the land is available, successful sugar-making can only be carried out by the largest factories with the best modern machinery. A statement of the class of factory needed in each tract would be of use.

The question of refineries should be considered, and whether it is more profitable for one factory to pass the cane through all its stages or for refineries to work up the material of numerous smaller concerns. Here, as elsewhere, the question of transport is likely to be a predominant factor. A suitable market for molasses should be obtained, whether as food for cattle, for use in tobacco curing or the distillation of spirit

The question as to whether and how far Government aid could be justifiably employed might be considered. This aid could be given in the establishment of gardens for the production of better classes of cane or for series of manurial experiments on a large scale. Small Government factories might be opened for demonstration purposes or, perhaps better, subventions might be given to private concerns worked under Government advice. In considering this question special reference should be made to past action, both private and official, and the results obtained.

Before launching on the latter action, however, a thorough study should be made of the local markets, the internal movements of the various classes of sugar in India and the recent attempts by foreign makers to capture the trade.

Some difficulties in sugarcane experiments.

The difficulties of carrying out all field experiments are well known. With ordinary crops, like the cereals for example, in which the produce of seed and straw can be weighed without much trouble, fairly reliable results can be obtained, provided all due care is taken. In the case of sugarcane, however, the matter is by no means so simple. Here the crop must be passed through the mill and the juice must be manufactured into sugar before the results of an experiment can be known. It is proposed in the present note to draw attention to some of the difficulties which beset those concerned with field experiments designed for the improvement of the sugarcane.

One of the first difficulties encountered is the sampling of a plot of sugarcanes, especially where numerous small plots have to be dealt with. It is not always possible to reap and turn each plot into sugar, separately. The usual practice in such cases is the following :—The plot is cut, the total weight of canes determined and a sample (say 100 lb.) is selected by some mechanical method and crushed in a small mill The juice is then analysed with the polariscope A calculation is now made by which the result is given in tons of sugar per acre. This method is not without its disadvantages, as will be evident when it is remembered that the weight of canes per acre is anything between 20,000 and 100,000 lb. Any error, therefore, in selecting a sample of 100 lb. will be multiplied by a factor varying from 200 to 1,000, when the results are expressed in tons of sugar per acre.

That unreliable and misleading results are obtained when canes are grown in small plots, and when the produce has not been made into sugar, has been clearly proved by Harrison * in British Guiana, who states : " No trustworthy way has yet been found to get the returns of plot experiments to conform with the results of field cultivation. We have often had results from plots that were simply astonishing. On paper a cane might yield six tons to the acre and yet we know well that tried on a larger scale the yield would only be about $1\frac{1}{2}$ tons.

* *Harrison* —" Sugarcane Experiments at British Guiana ".— *International Sugar Journal*, Volume 5, page 178, 1903

Apart from the tonnage of canes, there are many points that can only be settled by experiments on a large scale. The defective milling qualities and the deficiency of megass of some varieties cannot be discovered on small plots. For decision as to the economic value of a new variety of sugarcane, it is essential that results be recorded as on canes grown on estates' scale and treated under factory conditions. We have in British Guiana at the present time (1902) 27,000 acres under strict chemical control as perfect as exists in any part of the world. At all the plantations, experiments with seedling and other varieties are being carried on as a continuation of the experiments with varieties begun in small plots in the Botanic Gardens, and after careful selection, gradually extended to larger areas." It is interesting to compare the results calculated from the juice of small samples of the plots grown at the Botanical Gardens, British Guiana, with those obtained where the varieties were planted on a large scale on the estates and actually made into sugar. Some of these results are given in the following table:—

Number of cane.	625		145		B 147		78		74	
	Estates.	Botanical gardens.	Estates	Botanical gardens	Estates.	Botanical gardens	Estates.	Botanical gardens	Estates	Botanical gardens
Tons of sucrose in the juice per acre.	3·50	5·65	2 48	4·91	2 40	5 64	1·70	2·62	2 18	4·23

It will be seen from these figures that the results calculated from samples taken from the small plots are in many cases nearly twice those obtained from large plots where the canes were actually made into sugar. It is clear, therefore, that before a new cane can be recommended to the cultivators or to planters trials on a fairly large scale must be undertaken and the crop must be manufactured into sugar.

There must be some reason why a sample from a plot does not actually represent the crop of canes. *Do the individual plants of the same variety vary as sugar producers and do the canes of each stool vary in the same manner?* If they do, then we have at once one reason why a sample gives such misleading results. The recent researches of Kobus* in Java have shown that there is considerable variation in the same variety of sugarcane. It was found that well developed canes of equal age from the same plant show great differences in sugar-content, *e.g.*—

	Sugar content. per cent.
Mother stalk	9·2
Principal side shoot	13 5
Ditto	13·1
Ditto	6·9

Further, individual plants of the same variety were found to vary widely in sugar-content. In some cases these differences amounted to as much as 20 per cent. In view of the variation which is possible in a plot of canes both between individual plants and also between the canes of each stool, it is clear that no reliable results can be obtained if everything is based on the composition of the juice of a small sample such as 100 lb.

A second difficulty encountered in sugarcane work is to determine the proper time to reap the plots; in other words, to say when the cane is ripe and at its best. This difficulty applies not only to experiments with one variety, but also to a greater extent when several kinds of canes are tried one against the other. In manurial experiments, for example, it would be quite possible to find that nitrogenous manures delayed ripening to an appreciable extent. In such a case unless all the plots were cut and ground at their best, it is easy to see that the error due to cutting too early or too late might be greater than the difference due to the manurial treatment. Where varieties are grown one against the other, it is most necessary that all the kinds should be cut

* *Kobus*—"The chemical selection of the sugarcane"—*International Sugar Journal*, Volume 8, page 299, 1906 (The detailed papers dealing with the work have appeared in the *Java Archief* since 1898).

when they are first ripe, for otherwise it will be impossible to say that one variety is better than another. It is possible that the contradictory results sometimes obtained in variety trials in different years may be due to the difficulty in knowing when the cane is ripe. Since Went's investigations in Java in 1896,* I have been unable to find any more recent work on the changes in the composition of the cane before and after ripeness. Went found that at the period when the cane is ripe, the amount of sucrose is at its maximum, while the quantity of glucose is least. After this period is past, inversion takes place, the sucrose decreasing and the glucose increasing. The purity of overripe canes, therefore, falls. From the point of view of sugar-making, unripe and overripe canes are alike bad. Went also showed that inversion and loss of sugar takes place when aerial roots develop at the upper nodes and when the side buds grow out before the crop is ripe. Such varieties are, therefore, to be avoided as likely to yield an impure juice.

It is not easy to see how to overcome the possible error due to the difficulty of knowing when the cane is ripe. One obvious method of obtaining a more accurate result would be to cut the plots a third or a fourth part at a time. In this way it would be possible to see how long the canes remain at their best, and also to see what kind of error creeps into the result through the difficulty of knowing when the crop is ripe.

Another minor difficulty in experimenting with sugarcane, and indeed with all crops in India, is the question of keeping the varieties pure and preventing admixture. It seems to be the exception in India to find any crop of one variety only; mixture of types is the rule. In experiments where varieties are grown next to each other, it is often very difficult at cutting time to be sure that some mixture does not occur at the line of junction of the plots. To avoid this, the plots might be separated by a row of canes of a different colour or by a row of some striped variety. Such a method seems better than to separate the plots by open spaces, as this introduces the error of end plants.

It is naturally far easier to point out possible errors than to devise means for overcoming them. At the same time nothing is gained by carrying out experiments in the field in which fundamental errors are apparent. Workers on the improvement of the sugarcane in India must have the means at hand of getting their canes cut and made into sugar without delay. This naturally involves much time, trouble and expense. But if work is to be done in India of the same high class as that which has been done in Java for many years past, the workers in India must be provided with facilities such as are to be found there. Whether the sugarcane industry in India would justify such an outlay is another question.

A. HOWARD,

Imperial Economic Botanist.

The Improvement of the Sugarcane by Selection and Hybridization.

There are many references in the literature to the improvement of the sugarcane by selection, and experiments have been made on the subject from time to time. The general idea is to propagate the variety by using only the richest canes. In this way it is hoped to increase the yield of sugar in a similar manner to that so successfully adopted by Vilmorin in the case of the sugar beet.

None of the experiments on this point, however, seem to have been so thoroughly and successfuly carried out as those of Kobus in Java during the last ten years. The details of this work are to be found in the Java *Archief* since 1897. Recently this Investigator has contributed a summary of the results to the International Congress of Applied Chemistry at Rome in 1906 and a translation in English of the paper was published in the International Sugar Journal for June and July of that year (1906).

Starting from the variation in sugar-content between individual plants of the same variety, Kobus gradually developed a method of selection which

*Went —"Onder Zoekingen omtrent de chemische physiologie van het Suikerriet". —*Archief voor de Java Suikerindustrie* 4th Jaargang 1906, S. 525

was at once successful and practicable. He sums up his conclusions as follows :—

1. Different stalks of the same sugarcane plant vary widely in sugar percentage even when they are of the same age. Consequently we founded the chemical selection on the analysis of the juice of the hole plant, not on that of single cane stalks.

2. The variability in sugar-percentage of various sugarcane varieties is very different. Those grown from cane-seeds do not vary so much as the old varieties.

3. The juice of the heavier plants is richer in sugar than of the lighter ones, and those plants that have the richest juice are the heaviest.

4. Plants grown from cuttings derived from canes rich in sugar are heavier and contain more sugar than those grown from average plants or from plants poor in sugar.

5. When we select the richest canes from the descendants of canes that were already rich in sugar, and also the poorest canes from the descendants of poor canes, and go on in this way for some years, we very soon arrive at a considerable improvement of the rich canes (40 per cent. in five years) and a heavy depression in the descendants of the poor ones (60 per cent. in five years).

6. The descendants grown from cutting of once-selected canes remain richer in sugar for at least four generations, and show, as an average of 40 experiments, only a very small decrease.

7. The correlation of a high sugar-percentage in the juice and a heavy weight of the cane plant simplifies the method of selection in a remarkable way. It is sufficient to select those 20 per cent. that are the heavest, *i. e.*, the strongest tillered plants of the cane field, and plant the cuttings of one-half of these, *viz.*, of those richest in sugar.

8. We proved that differences in the juice of the descendants of rich and poor canes are already visible at an age of 30 weeks and that it is possible to perform the selection at that age in the fields we use in Java for the propagation of cane cuttings. Highly selected canes of 20 weeks did not show any difference in the juice of the rich and the poor plots.

In spite, however, of the success of the method employed, it appears that selection is only employed to a limited extent in the Java Sugar Factories. The reason of this lies in the fact that within the last few years the varieties raised from crossed seed have given distinctly larger yields. Further, these seedlings remain more constant in their sugar-content and do not vary so much as the older varieties. The parents selected for seed raising are specially selected, only those plants, richest in sugar, being employed.

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Bombay.

Introduction :—Mr. Barber's scheme for provincial enquiry into the sugarcane industry has been followed.

2. *Climate* :—Bombay Presidency is a long narrow tract extending from the extreme south of the Collectorate of Kanara, N. L 13° 53′ to the most Northerly point of Sind N. L. 28° 47′. It ranges in altitude from sea level to nearly 5,000 feet. As would naturally be expected, a great variety of climate is found. The rainfall within the sugaracane growing parts varies from 6″ or less in Sind to 140″ in Honávar Taluka of Kanara; but in the cane growing parts of the Deccan wherever 2/3 of the cane of the Presidency is cultivated, the average rainfall is from 22″ to 35″. The rainfall in Gujarat and Northern Deccan and Konkan is confined mostly to the five months, June to October, but the Southern Deccan and Konkan get late rains as well.

The mean daily temperature varies also quite widely, and the widest variations are found in Sind from 55° in January to 109° in July. In the principal cane growing districts of the Deccan the mean of the cold season

is 70°, the hot season 87°, and the rains 77°. The greatest extremes of this region in the last five years are 42° to 109°.

Further information is given in the statement in paragraph 4.

4. *Extent and character of cultivation*:—The average area for the last 20 years is 67,696. The area has fluctuated somewhat; but throwing out the famine year of 1900-01, when the area was less than 40,000 acres there have been no considerable variations, the largest area was in 1888-89 of 88,000 acres. The fluctuations follow the rainfall very largely as is seen in the appended statement.

Statement showing the climate and average acreage of principal sugarcane districts in the Bombay Presidency.

District.	Acreage under sugarcane.	Average rainfall.	Season of rainfall.	Mean Temperature.			
				January.	April	July.	October.
Sind.							
Karachi	830	7-66	June to March	64°	80°	89°	83°
Hyderabad	991	7-22	Ditto	65°	88°	90°	86°
Gujarat.							
Ahmedabad	901	31-39	June to October	73°	88°	87°	85°
Surat	3,208	39-58	Ditto	71°	86°	83°	82°
Deccan.							
Khandesh	East Khandesh 514 West " 548	22-40	June to October	73°	89°	85°	82°
Nasik	4,378	29-19	Ditto	67°	87°	78°	77°
Ahmednagar	1,698	22-68	Ditto	69°	85°	77°	75°
Poona	13,075	31-92	Ditto	77°	86°	78°	80°
Sholapur	1,928	25-99	Ditto	73°	90°	79°	78°
Satara	11,104	40-65	May to November	67°	88°	76°	77°
Karnatak.							
Belgaum	10,606	51-88	April to January	70°	81°	71°	73°
Dharwar	3,765	34-11	Ditto	72°	82°	78°	74°
Konkan.							
Thana	570	100-34	June to October	72°	86°	80°	80°
Kanara	3,221	118-81	April to January	77°	82°	79°	79°

Irrigation—Nearly all the sugarcane of the Presidency is grown under irrigation

In Sind, this like most other cultivation is irrigated largely from canals.

In Gujarat and Southern Deccan wells are the principal source of irrigation, while in other parts of the Deccan canals and tanks furnish most of the water.

Except in the canals of the Deccan the cane is raised in small areas very much scattered and is rotated with other garden crops. Along the canals of the Deccan it is the main crop and only rotated with other crops because it is found that the soil of this region cannot stand continual perennial irrigation. The soil of Sind and Gujarat is alluvial while that of the Deccan is from the decomposition of the basalt. In the Southern part of the Presidency the débris from primitive rocks is mixed with basaltic material.

5 *Varieties of Cane grown*:—

18 Varieties have been described by Mr. Mollison and Dr. Leather from this Presidency one of which is a reed cane "Hullu Kabbu," and I have had no opportunity of adding to this list. (*Vide* Text Book on Indian Agriculture, Vol III, pp. 159—171). I believe no wild cane is found in the Presidency.

Our canes are divided into hard and soft canes The various colours are all represented and can be seen from Mr. Mollison's description.

The percentage of juice as extracted by the bullock power iron mills under the ordinary conditions is put down by Mr. Mollison at 73 per cent. for soft canes, and 60 per cent. for hard canes. But in the case of Pundhia at the Sugarcane Farm at Manjri 79 per cent. of juice has been obtained with the same mill.

Juice :—Dr. Leather has made analysis of the juice of several of the varieties of the Presidency ; they show sugar percentages of 13 to 17.

6. *Recorded Introduction of new varieties* :—Mr. Mollison imported two varieties-Green and Red-from Mauritius in 1893. At first these were very poor in sugar, but they have been inproving until now they are nearly equal to the local Pundhia. They give considerably higher yield per acre of stripped canes than Pundhia, but not so much sugar. In 1903-04 yield of 52 8 tons was obtained from an acre, but some plots yielded at the rate of 57 tons, but the average yield of *gur* or jaggery was only $4\frac{3}{4}$ tons

Pundhia the same year gave an yield of 42·7 tons of stripped canes but produced $5\frac{1}{4}$ tons of *gur*.

A close study of the origin of many of our soft canes would probably show that they were of exotic origin.

7. "*Sports*" *and seedling canes* :—Stripped canes are often seen amongst Red varieties, but I know of no authentic record of any variety being so formed.

8. *Other sources of sugar and spirits* :—Sugarcane is the sole source of sugar. Spirits and intoxicating beverages are made from juice of the wild date or toddy palm (*Borassus flabellifer*) and the flowers of the Mowra tree (*Bassia latifolia*), etc.

The American sugar sorghum was tried by Mr Mollison in the year 1894-95 as a sugar crop but was a failure (For more details and results of these experiments, *vide* Annual Report of the Experimental Farm at Poona for the year 1894-95)

9. *Planting and reaping seasons* :—The planting season varies in the different divisions of the Presidency and is shown in the statement below :—

Name of the District.	Time of planting.	Time of harvesting.
Sind.		
Karachi	January to April	December to March.
Hyderabad	(i) December to February	November to January.
	(ii) February to June	January to April.
Shikarpur	January to March	September to January.
Thar and Parkar	November to February	August to November.
Gujarat.		
Ahmedabad	April to May	February to May.
Kaira	Ditto	February to April.
Panch Mahals	(i) April	Ditto.
	(ii) January to February	December to January.
Surat	October to January	September to January.
Deccan.		
Khandesh	January to April	December to April.
Nasik	January to March	February to April.
Poona	January to May	November to May.
Ahmadanagar	(i) January to February	December to February.
	(ii) March to April	February to March.
Sholapur	January to May	December to May.
Satara	(i) January to May	Ditto.
	(ii) November to March	November to February.

Name of the District	Time of Planting.	Time of Harvesting.
KONKAN.		
Thana	(i) May to June (ii) November	March to May. December.
Ratnagiri	January to March	December to January.
Kanara	December to January	December to February.
KARNATAK.		
Belgaum	February to May	February to May.
Bijapur	April	March to April.
Dharwar	January to March	January to March.

10 *Rotations and mixed cropping* :—The rotations adopted in different parts of the Presidency vary very much and are given below :—

Sugar cane is grown continuously in Sind .

In Northern Gujarat, Ahmadabad, there are two systems according to the nature of the land used for cane.

(*a*) Land which is unirrigated for several years and has been cropped with such dry crops as cotton, *jowar*, *tal*, etc., is preferred for cane. Then a crop of sugarcane is taken which is followed by chillies, brinjals, etc., but not by cane again for several years to come.

(*b*) The second system is adopted on garden land. Cane follows a preparatory dry crop like *bajri* or fallow and the cane in its turn is followed by brinjals, chillies, and vegetables and later by dry cropping. No cane is afterwards taken for five or ten years. The rotation crops do not, however, follow a definite system.

In Surat district, there are again two systems.

1. Cane.
   Jowar.
   Cotton and dry rice or mixture of rice and *jowar*.
2. Plantains for 2 years.
   Ginger.
   Cane.
   Instead of ginger, turmeric and yams, groundnut or other vegetables may be taken.

In the Deccan and Khandesh the kind of irrigation whether well or canal determines the system followed.

Well-cultivation :—Sugarcane is ratooned once or twice and is rotated with any of the following crops :—

Groundnut, chillies, onion, Khapli wheat, fodder, *jowar*, gram, vegetables.

No exact order of rotation is followed, but cane is not planted again for four years.

Canal cultivation :— Under this style of cultivation the ryots endeavour to get as much land under cane as possible and rotate only when obliged to do so to keep the physical condition of the soil right.

Fodder *jowar*, Khapli wheat, gram, groundnut, chillies, turmeric, onion are used as crops for rotation. Only one such crop followed by a year of fallow or green manure or even without such preparatory treatment is taken between each planting of cane.

In Karnatak there are two systems as follows :—

1. On rice land :—
   Cane.
   Garden crops like chillies, sweet-potato, onion, and cabbage for two years.
   Rice for one or two years
2. Other lands :—
   Cane (ratoon sometimes).

Potatoes and wheat;
Garden crops chillies, onion, sweet-potato and cucurbits *jowar*.
In Konkan
1. Basein and Mahim (Thana):—
Betel vine
Ginger
Cane
Plantains.
2. In other parts:—
Cane rotates with other vegetables about once in 3 or 4 years.

11. *Ratoons.*—In Gujarat and Konkan the cane is never ratooned. It is ratooned once in Sind and Karnatak and some times twice in the former division. In the Deccan, one, two or sometimes even 4 to 6 ratoon crops are taken.

12. *Preparation of the land for planting* :—In Sind, when the land is first irrigated, 4 or 5 ploughings with a light two-bullock plough are given to a depth of 4 to 6 inches; after every ploughing a heavy plank is drawn over.

In Ahmedabad, 15 to 20 ploughings with a light wooden two-bullock plough are given. Three acres can be ploughed in a day. All ploughings are given after the monsoon breaks. This operation continues throughout the year from the break of monsoon to the time of planting in April. The land is harrowed with a plank harrow between each ploughing. The blade harrow is used when weeds are to be eradicated. The plough goes 4 to 6 inches.

In Surat, the land is prepared with 4 to 8 ploughings with a medium sized two-bullock plough. Last ploughing is followed by the plank. Thus the soil is stirred to a depth of 6 to 8 inches.

In Khandesh the operation of ploughing begins after the rains are over. Two ploughings with a two-bullock heavy plough are given with a turn of harrow between each ploughing. The clods are broken by mallets.

In the Deccan, 6 to 10 bullocks are required to draw the heavy plough that is used and 3 ploughings are given. A long-harrow—a heavy *babul* log squared and drawn by two pairs of bullocks—is used between each ploughing. After second ploughing harrowing with bladeharrow is resorted to. Clods are broken by hand. The plough generally goes 9 inches deep. The corners and sometimes the whole land when it is very foul is hand-dug.

In Karnatak, the plough used is a heavy one and drawn by 4 to 6 bullocks. 4 to 6 ploughings are given. The plough goes 4 to 6 inches deep. The after treatment is the same as in the Deccan.

In Konkan, two ploughings and eight harrowings are considered necessary for sugarcane.

13, 14, 15, 16.—*Planting. The source from which the seed is obtained. The part of the cane used for planting. The actual preparation of the sets for planting* :—

Special " Stand-overs " are only seen in Sind.

The sets used for planting have generally three buds and are cut from the whole canes in Sind, Northern Gujarat, Karnatak, parts of Khandesh and Satara and Sholapur.

The practice of propagating from the tops only is common in parts of Khandesh, Satara and Sholapur and in Konkan except Thana.

In the Surat district the whole cane is planted.

No steeping is practised in this Presidency.

17. *The number of sets per acre.*—The average number of sets required to plant an acre is 16,000 to 18,000; Ahmedabad requires more, from 20,000 to 24,000 sets while the exact number of Sind is not available, but probably a very large number (40,000) is necessary.

18. *Mode of planting.*—In Sind, beds are prepared 10 by 12 feet and sets are stuck obliquely into the soil about half their length at a distance of from 6 to 10 inches or they are pressed into the soil horizontally in line one foot apart, the sets being end to end. The beds are dry at the time of planting but water is immediately let in.

In Ahmedabad, furrows are made 9 inches to 12 inches apart with cross-furrows for every 9 feet. Beds are then completed by hand 9 feet by 6 feet.

Sets are pressed into dry earth horizontally at a distance of 2 to 4 inches between each set and water is let in.

In Baroda beds are made and one set 15 inches long planted in pits 4 inches deep. The pits are in rows 4 inches to 6 inches and the rows are 2 feet.

In Surat, the whole canes are passed top-foremost through a heavy plough which buries the cane 4 to 6 inches. A man follows the plough and tramples the earth. The surface is smoothed and turned into shallow beds for watering. As soon as the water dries the soil is turned to a depth of 3 inches with a shallow plough. When germination takes place regular irrigation beds are formed.

In the Deccan, the land is ridged up with the plough into ridges 24 to 28 inches apart, the furrows being as deep as possible. The plough is then run across the line of the ridges to form parallel water-channels 10 feet apart. Finally the field is laid out into beds 10 feet square. The sets are laid on the ridges of each compartment. Water is turned into each bed in turn. When the water has partially soaked into the soil and softened it, the planter begins to lay the sets carefully in the bottom of the furrow trampling each set down to 2 or 4 inches into the soft mud. The distance between sets is about 4 inches.

In Khandesh the process varies in that the sets are not placed on ridges, but are carried in a basket by the planter.

In Karnatak no beds are formed; sets are put in furrows made by a plough 3 to 6 inches deep and trampled in and water let in.

In Konkan furrows 2 feet apart and 8 feet long are dug by hand-hoe and 8 sets are planted in each furrow. In July the ridges are split up.

19. *Supplying vacancies.*—Sometimes sets are put in at the time of watering after germination to fill up blanks.

20. *Seed bed and Nursery.*—In some places in the Western Deccan the sets are germinated in beds with irrigation and transplanted in the rains and grown without irrigation.

21. *Stool-planting.*—The practice of stool planting is unknown in this Presidency.

22. *Irrigation and Drainage.*—Only soils naturally well drained are usually selected for sugarcane. No artificial drainage is resorted to except that open trenches are kept in canal irrigated region in low places to take away surplus irrigation water.

In Sind, the irrigation is from perennial canals and wells to supplement the inundation canals.

In Gujarat, the water for cane is from wells of varying depths from 25 to 50 feet.

In the Deccan wells from 20 to 40 feet and canals leading from artificial reservoirs supply water for sugarcane.

In Karnatak, from wells and tanks.

In Konkan, from streams and wells.

From 2,000 to 4,000 acres are grown without irrigation but in some cases when first put into ground plants are watered.

23. *After Cultivation* —The after cultivation depends upon the weeds. Usually from 3 to 5 hand-weedings are given, a small sickle-shaped weeder being used.

In Surat, the crust is broken up after every watering with a small pick.

In the Deccan and parts of Karnatak and Konkan when cane is 4 or 5 months old, the earth is dug up with a pick and hoed up against the cane.

Mulching is practised in parts of Karnatak with newly planted cane for semi-dry cultivation.

24. *Manuring.*—In Sind, 25 to 30 cartloads of farm yard manure and a small dressing of goat manure form the principal manure. Earth from old village sites is also sometimes given.

In Northern Gujarat, 60 to 100 loads of farm yard manure as also sheep-folding is resorted to; a dressing of castor cake is given.

In Surat, 30 loads of farm yard manure is given, but the land is often prepared with a crop of *sann* (*Crotolaria juncea*) as green manure.

In the Deccan, under the well-irrigation, 30 to 40 loads of farm yard manure with about 1,900 lbs. of castor (*Ricinus communis*) cake or *Karanj*

(Pongamia glabra) cake are the chief sources of manure. Sheep-folding is also resorted to.

In the canal areas 30 to 80 loads of farm-yard manure or poudrette are used. These are supplemented by heavy dressings of the oil-cakes-Castor (Ricinus communis) *Karanj* (Pongamia glabra), Niger (Guizotia abyssinica) and Safflower (Carthamus tinctorius) as high as 3,000 lbs. being given. A preparatory crop of *San* (Crotolaria juncea) as green manure is grown.

In Karnatak, sheep-folding, Niger (Guizotia abyssinica) for green manure and farm yard manure at the rate of 40 to 60 loads are used.

In Konkan, a small dressing of farm yard manure is given at planting and three dressings of castor cake making a total of 1½ tons are applied.

In other parts of Konkan fish-manure is the principal manure

The farm yard manure is always ploughed in. The dressings are worked into the soil at the time of weeding or earthing up. The trash, when not required for fuel, is burnt on the land.

Statement below shows analysis and average number of lbs. per Rupee, and area under crop from which the cake is obtained with approximate yield.

Name of Cake.	Percentage Comp.			lbs. per rupee.	Area of crop. (1901-05.)	Approximate cake per acre.
	N.	K_2O.	P_2O_5.			
						lbs.
Safflower	4·9	1·2	·8	60 to 80	704,459	750
Bassia	2·6	...	·9	80	Not available	...
Cotton seed . . .	2 5	2·1	1·2	40	3,605,985	250
Castor cake . . .	3 8	...	1·7	45 to 60	72,599	300
Karanj	3·5	...	·65	60	Not available	5
Groundnut	7·8	...	1·5	30	76,692	1,200
Sesamum	5·0	...	1·9	35 to 45	382,372	250
Nigerseed	4·47	0 7	1 6	35 to 45	177,642	180

In addition to these, cake is brought into the Presidency from other parts of India.

The results of Manjri experiment were summarised by the writer in a note compiled in 1904, an extract from which appears below :—

These experiments were conducted in two plantings in different years with two successive crops grown in each of them, and the following facts have been more or less satisfactorily demonstrated from the same.

(*a*) That at Poona the amount of nitrogen present in the sugarcane soils determines the yield.

(*b*) That the most economical quantity of nitrogen to be applied is between 350 to 400 lbs. per acre, although the amount actually consumed is much less.

This crop receives so much irrigation that much of this above soluble plant food is lost by leaching into the sub-soil.

(*c*) That if the above quantity of nitrogen is supplied in two dressings, it will give better results than when used as a single dressing.

(*d*) That the nitrogen found in oil cakes is more available, and acts more quickly than that found in farm yard manure.

(*e*) That in Poona the safflower cake and cotton seed furnish the nitrogen cheaper than other forms of manure, containing that element.

NOTE.—The price of farm yard manure around Poona is abnormally high.

(*f*) That phosphatic manures, such as bone meal or superphosphates gave unsatisfactory results even when reinforced by crude nitre.

Details of these experiments appear in Mr. Mollison's Text Book on Indian Agrioulture, Vol. III (Pages 136 to 141) and Agricultural Ledger No 8 of 1898.

The value of the ashes from the sugar making is known in several places but they are not considered as valuable as they ought to be.

25. *Treatment of the canes during growth* :—

In Gujarat, the canes are usually tied up for convenience of work. In Konkan the leaves are stripped and the cane wrapped and tied. Whenever lodging appears troublesome tying is commonly resorted into all parts of the Presidency.

The hard canes are sometimes planted around the border of the soft canes to discourage jackals and pigs.

26. *Treatment of the fields preparatory to reaping the cane* :—

In Deccan, Karnatak and Konkan heavy irrigation is applied just previous to reaping.

In Gujarat and Sind no special irrigation is given.

27. *Disease phenomena.*—Fungus diseases are uncommon, and their attacks are usually insignificant.

Of the insect pests the moth-borer and white ants are the most serious.

28. *Diseases affecting the sets after planting.*—Only jackals and pigs do harm to the sets.

29. *Diseases affecting the whole plant.*—Ustilago is sometimes seen ; but is not a serious trouble

Moth-borer is very injurious to newly planted cane especially when planted late.

30. *Disease confined to the underground parts of cane plants.*—Striga exists but its attacks are not of great consequence. White ants are very troublesome in the sandy tract. In fact they make cane cultivation impossible in some localities.

31 and 32. *Diseases affecting the stem. Diseases affecting the leaves.*—Except moth-borer mentioned in paragraph 29 inconsequential and not worked out.

33. *Reaping. Time of cutting the cane.*—Ripening in the Deccan is ascertained by small trial boilings. In Gujarat the time is found out by appearance and by taking the age into account.

For dates of harvesting please see paragraph 9.

34. *Deterioration after cutting.*—Cane is always milled as soon as possible after cutting.

35. *Mode of cutting the canes.*—In Sind, cane is cut as olosely as possible with a sickle.

In Gujarat it is uprooted, sometimes with the assistance of a sickle.

In Deccan, Karnatak and Konkan when ratoon is to be obtained it is cut with a sickle, when no ratoon is to be kept it is up-rooted. Only one cutting is given. The canes are stripped of the dry leaves in the field, but the tops are cut off at the mill and the cane cut into pieces suitable for feeding the mill.

6. *Yield per acre in canes.*—The statement below shows the yield in canes per acre in different parts of the Presidency as given by crop experiments:—

District	No. of canes per acre in lbs.	Total weight per acre in lbs	Weight of stripped canes per acre in lbs	Weight of tops per acre in lbs.	Weight of juice per acre	Weight of *gur* per acre in lbs.
SIND.						
Karachi	35,090		12,310			...
GUZERAT						
Ahmedabad	...	76,620	59,900	16,720		
Surat—						
(Soft canes)	25,870	..	105,051		...	..
(Hard canes)	46,580	...	69,790	..	...	
KONKAN.						
Thana		70,195	62,440	8,055		
Kanara	26,760	...	...	..	..	...
DECCAN						
Nasik	31,024	...	...		...	
Poona	..	65,480	...			...
Do.	...	88,450	77,980	10,470	55,400	10,180
MANJRI FARM						
Experimental plots, 1900	39,712	114,128	97,088	17,040	76,000	13,041
Do. Manjri plots, 1901		...	1,28,000	...	78,080	10,000
Satara	35,430	39,051	80,034	9,017	..	...
Do.	25,700	...	49,460	19,980		
Do.	22,600	...	30,910	13,620		...
KARNATAK						
Dharwar	...	19,200	12,960	6,240	...	2,590

37. *Manufacture of Jaggery or gur.*—Mr. Mollison's Book on Indian Agriculture, Volume III, pages 123 to 132, may be referred to.

In Sind they have a very cumbrous wooden mill, the camel drawing the mill by walking around on a platform built above the mill. The pans are larger than in other parts of the Presidency.

38. *Profit and loss on sugarcane cultivation*:—

The following data will furnish useful information regarding the cost of cultivation and net realisations from sugarcane per acre.

Details	Rs	As.	P.
Cost of cultivating an acre of sugarcane in Poona District :—			
Ploughing by contract 3 times in October, November and December	22	0	0
Breaking clods, 20 women (first time)	1	11	0
„ „ 12 women (second time)	1	2	0
Levelling with maind	0	10	0
50 cartloads of farm yard manure including cartage expenses after the second ploughing	75	0	0
Spreading manure	2	0	0
Digging and cleaning corners and headlands	2	0	0
Levelling second time	0	6	0
Ridging and making furrows for water course	0	12	0
Making beds by contract	2	0	0
Cost of 16,000 sets (Price varies according to price of *gur*)	50	0	0
Cutting sugarcane sets	2	0	0
Carrying, spreading, watering and planting sugarcane sets	2	0	0
Hand-Weeding 5 times from June to May	12	0	0
Top-dressing with castor cake in July with 20 *pullas* (1,800 lbs.) at Rs 4 per *pulla*	80	0	0
Crushing and spreading castor cake	3	12	0
Earthing up by contract	8	0	0
Watching and watering, 1 man on Rs. 7 per month for two acres	42	0	0
Erecting a shed near the boiling pan	5	0	0
Castor oil for mills and kerosine oil for lamps and sweet oil for boiling pan	5	0	0
Cutting, carting and crushing cane by contract 64 boiling pans at 14 annas each	56	0	0
Cloth	2	0	0
Sugarcane mill hire for 16 days at 8 annas per day	8	0	0
Assessment	1	1	0
Canal charges	40	0	0
Total	424	12	0
Cost of cultivating an acre of sugarcane in Surat :—			
Two ploughings in October and November	10	8	0
Carrying and planting sets	2	8	0
15 to 20 tons (45 cartloads) manure at 12 annas a cart before planting	33	12	0
Watering from a well 6 to 9 times, each time 4 bullocks and 3 men for 5 days	45	0	0
Hand-hoeing 4 times, each time 10 men	5	0	0
Half value of *kos* (bag) and ropes	6	0	0
Fencing	5	0	0
Castor cake 25 maunds (1,000 lbs.) at 8 annas per maund applied in July	12	8	0
Crushing cake and applying the same, 16 men	2	0	0
Cutting cane and making *gur*, 12 men at 4 annas and 12 bullocks for 7 days	32	0	0
Fuel for boiling	35	0	0
Hire of wooden mill at Rs 1-8-0 per day for 7 days worked night and day	10	8	0
Earthen pots at Rs. 4 per 100 including cartage	9	0	0
1 800 seed canes (price depends upon price of *gur*)	50	0	0
Sundry expenses	10	0	0
Land assessment 2 years	20	0	0
Total	288	12	0

A crop which is not properly manured and attended to yields above 8,000 lbs of *gur* per acre. An average good crop produces about 9,500 lbs. The yield, under suitable manuring, goes as high as 13,500 lbs. The price of *gur* varies from Rs. 3-8-0 to Rs. 5 and more per maund of 80 lbs.

39. *Character and richness of the Juice* :—

Statement showing the analysis of the varieties of cane made by Dr. Leather are given below :—

Name of Cane.	Sample grown at	Year of analysis.	Acclimatized for years.	Percentage of juice to cane.	Percentage of sugar to juice.	Percentage of glucose to juice.
REED CANES.						
Hullu Kabbu (S M. C.)	Poona Farm	1896	Fresh importation	52·60	16·06	trace
Do. do.	Do	1897	One year	56·17	16·90	0·70
Do. do.	Belgaum	1896	Local	55·90 to 59·80	14 27 to 14 92	trace to 0 74
HARD CANES						
Surat Vansi	Poona Farm	1896	Fresh importation	57·70	9·53	1 51
Do.	Do.	1897	One year	59·09	11·50	1 0
Do.	Belgaum	1896	Local	60 0	12·61	0 95
Ratnagiri Deogadi	Poona Farm	1896	Fresh importation	70 50	11·46	1·87
Do. do.	Do.	1897	One year	68 0	11·9	·9
Belgaum Sannabile	Do.	1896	Fresh importation	60·0	17 38	·6
	Do.	1897	One year	58·20	16·0	·90
	Khanapur	1896	Local	58·29	13·31	1·09
SOFT CANES.						
Surat Khajuria	Poona Farm	1896	Fresh importation	59·15	10 98	1 40
	Do.	1897	One year	67·25	14·80	1 0
Mahim Yellow Green	Do.	1896	Fresh importation	71·0	12 38	1 87
Do. do.	Do.	1897	One year	70·58	14 80	·80
Pundhia	Do.	1896	Local	68 to 73	16 to 17·4	1·2 to 1·6
Do.	Belgaum	1896	Local	68 to 73	13 71 to 17·49	·83 to 1·57
Bijapur Purple Cane	Poona Farm	1896	Fresh importation	63·0	13·27	1·33
Do. do.	Do	1897	One year	62 50	13·80	1·00
Bassein Purple cane	Do.	1896	Fresh importation	57·10	13·31	1·22
Do. do.	Do.	1897	One year	64·80	13 60	1·70
Belgaum and Ranebennur Kare Kabbu (Belgaum cane).	Do.	1896	Fresh importation	60·70	11·67	1·51
Do. (Khanapur cane)	Do.	1896	Do.	63·00	6 13	2·57
Do. (Ranebennur)	Do.	1896	Do.	54·40	10·27	1·60
Do. (Belgaum, Khanapur and Ranebennur).	Belgaum, Khanapur and Ranebennur.	1896	Local	60 70 to 66·0	13·32 to 16 67	0·85 to 1·17
Ramrasdali (Kanara)	Poona Farm	1896	Fresh importation	70 10	8·22	2 41
Do.	Do.	1897	One year	63 70	14·50	·80
Yellow Green (Chickodi)	Do.	1896	Fresh importation	65 50	11 35	1·80
Do.	Do.	1897	One year	68 47	14·90	1·90
Do. (Ranebennur)	Do.	1896	Fresh importation	64 10	12·01	1·18
Do. (Bijapur)	Do.	1896	Fresh importation	70 40	14 30	1·57
Do.	Do.	1897	One year	70 62	16·60	1·10
Do. (Bagalkot)	Do.	1896	Fresh importation	68 40	12 34	1·94
Do.	Do.	1897	One year	68 75	16 20	1·40
Haliyal Rasdali	Do.	1896	Fresh importation	60 40	13·18	1·49
Do.	Do	1897	One year	62·14	15·30	1·00
Streaked (Gadag)	Do.	1896	Fresh importation	70·20	8 87	2·12
Do.	Do.	1897	One year	69·86	14·50	0 50
Streaked	Belgaum, Khanapur and Gadag.	1896	Local	71·	14·55 to 17 37	0·79 to 1·39
Green Mauritius	Poona Farm	1896	Three years	65·70	11·71	0 99
Do.	Do.	1897	Four years	68·75	14·10	1·40
Red or Purple Mauritius	Do.	1896	Three years	66·75	12·88	1·62
Do. do.	Do.	1897	Four years	65·17	12 50	1 20

40. *Sugar making.*—Formerly sugar was made in Bassein (near Bombay) in considerable quantities but the importation of Mauritius sugar has killed this.

The juice is boiled over a very slow fire and the syrup in a semifluid condition is poured into earthen jars. This syrup is called *rab* These pots are kept in slated benches or upon pots similar to those used for potting rose and other large plants. Small holes are made in the pots that contain the *rab* and another pot is placed below to collect the treacle. A plug of moss is put over the mouth of the *rab* vessel and water is sprinkled over it. The treacle leaches off and leaves the crystalline sugar into the pot, the top layer of which is white sugar and is called in vernacular "Flowers of Sugars," the lower layer is darker and is called "Grain Sugar."

One-third is of the first sort and the remainder is "Grain Sugar." The two sorts are separated and pulverised.

Second method:—

There are two boiling pans on the some furnace one large and the other small. Scum is removed as it appears and 10 to 20 tolas of lime is added to every 100 gallons of juice. When the juice has become somewhat thick it is transferred through a strainer to the second pan.

The boiling is continued slowly till the syrup has reached a state that upon cooling, granules of sugar are formed; the pan is taken off the fire and when almost cooled the mass is transferred to earthen pots and the mouth covered with paper and plastered tightly with mud. The pot is put on benches as in the first method. The bottom is perforated the next day with one or more small holes. Six weeks are required for a complete draining.

Some variations of the above processes exist.

Rock candy or sugar candy is also manufactured.

No large factory exists in this Presidency. Two refineries one at Mundhwa (near Poona) and the other at Gandevi (near Navasary) exist. An account of them will be sent in near future when further information is expected, as also some information from the Chamber of Commerce.

41. Impovements in Bombay should be along the development of the Deccan Irrigation Canals; more extended use of artificial manure better cultivation in Sind and investigation of white ants question in Gujarat.

In closing I wish to acknowledge the valuable assistance rendered to me by Mr G. K. Kelkar, Inspector of Farms, and Messrs. Fatechand, Sant, Kolhatkar and Ranade, Agricultural Training College teachers.

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POONA,
1st February 1907.

STATEMENT SHOWING THE AVERAGE RAINFALL IN INCHES IN THE PRINCIPAL SUGARCANE GROWING DISTRICTS OF BOMBAY AND THE AREA UNDER SUGARCANE IN ACRES DURING THE YEARS 1885-1886 TO 1905-1906.

Year.	Rainfall.	Area under sugarcane.	Year	Rainfall	Area under sugarcane
1885-1886	31·25	66,000	1896-1897	33 50	67,000
1886-1887	33 00	71,000	1897-1898	30 25	55,0 0
1887-1888	32·00	80,000	1898-1899	30 25	59,000
1888-1889	28·50	88,000	1899-1900	11 25	71 000
1889-1890	31·50	66,000	1900-1901	28·50	39,000
1890-1891	30·25	63,000	1901-1902	26 25	52,000
1891-1892	21 25	76,000	1902-1903	27·50	56,000
1892-1893	29·50	69,000	1903-1904	26 25	59,000
1893-1894	35·50	86,000	1904-1905	16 00	59,000
1894-1895	33 00	87,000	1905-1906	28 00	58,000
1895-1896	32 75	73,000			

Note—The rainfall represents the average rainfall of Satara, Belgaum, Poona and Nasik, while the sugarcane area is for the whole Presidency.

LETTER FROM THE BOMBAY CHAMBER OF COMMERCE, DATED THE 13TH FEBRUARY 1907, REGARDING THE IMPORT TRADE IN SUGAR IN BOMBAY.

I am directed to acknowledge receipt of your No. 191 of the 31st ultimo, and to submit the following information in reply to the queries contained therein :—

(1) The Import Trade in sugar is in a somewhat abnormal state at present, as contrary to what has been the case for several years past, imports of Continental beet sugar have lately fallen off to a very great extent. White Javas have come into favour and these are largely replacing beet sugars. A fair amount of White Java has recently been put through Bombay at about 9*d.* under the rate ruling at home for Austrian beet ; and as the Bazar difference between Austrian and Javas is only one anna per cwt. in favour of Austrian, business in the latter description is impossible.

The demand of the native consumers largely influences this trade. Now-a-days the better classes of natives prefer the white sugars to the usual locally produced "jaggery ", or to the Brown Mauritius, and for such white sugars they have to look to the countries producing white qualities such as Austria, Germany and Java. These white sugars, imported through Bombay, find their way to Guzerat Districts, *viz.*, Surat, Ahmedabad, etc., and on the Great Indian Peninsula line they go as far north as Delhi.

As to the chance of replacing imported sugars by sugars manufactured from superior plants in this country, this is a question my Committee are not prepared to give an opinion on, as it is one that would more appropriately be decided by an agricultural expert. However, allowing that conditions for growing canes are as favourable in India as they are in Mauritius and Java, the utilization of superior machinery for the manufacture of White Sugars in this country, would, it is believed, prove a profitable investment. Such sugars when compared with Java and Mauritius sugars would have the advantage of saving the ocean freight (from 12 to 15 shillings per ton), as well as the 5 per cent. Imperial duty. There would also be the further advantage of cheap labour, compared with that of Austria and other Continental Countries.

(2) The imports of foreign sugars into the Bombay Presidency (excluding Sind), during the past 5 years, are herewith given on a separate sheet.

(3) The restrictions placed on sugars favoured by Bounties, whether direct or indirect, are believed not to have proved beneficial to India. The only countries that benefitted by Bounties were Mauritius and Java, and to a lesser degree the United Kingdom through a few of her refiners. It is not thought that the restrictions on imported sugar had any appreciable effect on the refineries in this country, nor on its sugar cultivation. Broadly speaking the countervailing duty of something over a rupee had practically no effect on imports of any sugar. An additional duty of about Rs. 3 was subsequently imposed to meet the sugar refined under the Cartel system in Austria, and this had the effect of making the sugar in question too expensive as compared with cane sugar shipped from the United Kingdom and some other beet sugars which replaced it.

Some further information on the subject will be found in the Report of the First Conference of Indian and Ceylon Chambers of Commerce, January 1905, in pages 52 to 59.

Sugar (Refined).—The following table shows the quantities and sources of supply of the Imports of this article during the past five years:—

Whence Imported	1901-02.		1902-03		1903-04		1904-05		1905-06	
	Cwt	Rs	Cwt	Rs	Cwt	Rs	Cwt	Rs	Cwt	Rs
United Kingdom	1,810	23,750	75,106	7,36,530	63,546	6,60,773	1,613	21,281	108,955	10,19,111
Austria-Hungary	555,619	60,33,559	353,227	35,03,014	112,786	11,00,199	111,110	15,53,164	517,149	48,01,093
Belgium	1,000	12,370	14,819	1,45,197	397	4,189	-		67,770	6,09,777
France	59	664	20	231	121	1,654	99,502	1,91,167	86,211	7,96,611
Germany	111,163	12,57,159	20,250	2,02,591	1,961	49,070	58,672	1,19,457	202,731	18 16,550
Holland			31,077	3,11,032	11 525	1,17,261	-	..	...	
Mauritius	1,533,791	1,60,72,254	1,511,762	1,49,29,011	2,001,018	1,94,17,275	1 627,764	1,61,29,589	1,563,120	1,65,89,027
Reunion	..	..	...	..	3,641	36,415	20,974	2,31,089	35,183	3,42,183
Egypt	17,124	1,71,627	6,315	68,927	67,221	7,00,991	165,737	20,82,947	65,910	7,37 531
Honkong	109,379	12,02,673	224,103	23,24,272	113,954	15,51,030	114,560	13,65,179	67,011	8,33,189
Java	..	.	50,512	4,78,838	156,065	14,91,733	252,196	27,12,347	217,617	21 81,101
Straits Settlements	..	1	52,650	4,90,113	3,273	33,075	73,198	7,81,010	5,155	50,250
Other Places	5,902	69,198	1,126	10,769	87	1,175	122	1,599	138	1,024
TOTAL	2,738,200	2,19,31,810	2,377,271	2,35,34,202	2,571,398	2,52,21,610	2,067,647	2,00,25,157	3,062,289	2,98,73 416
Re-Export	52,093	6,11,671	21,119	2,27,819	29,291	3,02,591	10,023	1,29,705	139,976	15,19,125
Exports in Coasting Trade	411,373	47,16,660	780,144	37,70,195	569,710	57,47,558	178,804	17,84,436	605,150	61.74,027

J. B. LESLIE ROGERS,
Secretary, Bombay Chamber of Commerce

Bombay, 13th February 1907

United Provinces of Agra and Oudh.

So much literature on this subject is in the possession of the Agricultural Departments that it would be a waste of labour to all concerned to repeat the available information in a new form. The indigenous methods of cultivation and manufacture are detailed in *The Sugar Industry of the United Provinces*, by Mr. Muhammad Hadi, published in 1912; some results of the attempts to improve native methods will be found in Bulletin, No. 19, issued by this department: experiments with sugar-beet are described in Bulletin, No. 13; and a discussion of the prospects of the industry has recently been contributed by me for publication in *The Agricultural Journal of India*. The following notes are supplementary to the information already available. The numbers of the paragraphs refer to Mr. Barber's scheme of enquiry.

Part I.—Introduction.

2. *Climate.*—Table I gives the monthly and annual mean temperatures recorded at the four observatories situated in the principal cane tracts:—

Month.	Meerut.	Bareilly.	Benares	Gorakhpur.
January	57·8	58·4	61·3	61·2
February	61·5	62·4	66·3	65·3
March	72 2	73·3	77·4	76·5
April	83 3	84·1	87·5	86·4
May	89·5	89·8	92·3	89·2
June	90 5	89·7	91·0	88 4
July	86 1	85·2	85·5	85·3
August	84·6	84·0	84·2	84·3
September	83·3	83·2	84·2	84·1
October	76·5	77·5	79·1	79·4
November	66 0	67·0	69·1	70·0
December	58·8	59·4	61·7	62·4
Annual	75·9	76·2	78·3	77·7

Table II shows the mean number of wet days and the mean rainfall at the same observatories:—

Month.	Names of observatories.								Remarks
	Meerut.		Bareilly.		Benares.		Gorakhpur.		
	Number of rainy days	Rainfall	Number of rainy days	Rainfall.	Number of rainy days.	Rainfall.	Number of rainy days.	Rainfall.	
January	2·30	1·35	2 36	1·05	1·40	·67	1 50	·76	
February	1·10	·90	1·18	·74	1·20	·46	1·30	·49	
March	1·40	03	1·82	·76	·80	·25	·70	·38	
April	·90	·10	·45	·17	·40	·13	·50	·45	
May	1 50	·40	2·27	·76	1 00	64	2 40	1·84	
June	4 00	3 49	4 91	5 9[illegible]	6 80	6 23	7·70	9 09	
July	9 40	9·35	13 45	15·17	14 60	11·45	14 70	18 75	
August	9 40	9 81	12·18	14 43	13 10	12·05	14 10	13 24	
September	5·00	5 30	6 78	7 01	8 40	6 03	8 60	8 08	
October	·70	·35	·91	1·00	2·70	2·55	2·10	4·19	
November	·20	·13	·27	·18	·30	·31	·10	·15	
December	·90	·49	·61	·33	40	·21	·40	·14	
Total	37·00	32 07	47 17	47 80	50 90	40 99	54 10	52·01	

3. *History.*—I have nothing to add to the facts stated in Chapter I of Mr. Hadi's Monograph.

4. *Area.*—The cane area in these provinces fluctuates with the nature of the sowing-season, the price of food-grains, and the prosperity of the

community; it shows no tendency to advance or decline during the last twenty years. The following figures indicate the extent of the fluctuations :—

		Acres.
10 years 1886—1896	Maximum	1,389,000
	Minimum	1,060,000
	Average	1,230,000
1901		1,212,000
1902		1,229,000
1903		1,152,000
1904		1,090,000
1905		1,213,000
1906		1,221,000

The crop now in the ground has not yet been measured, but it is reported to be the largest on record.

Cane is practically confined to the Gangetic alluvium: it is very rarely grown on the Central Indian alluvium and still more rarely on the rock-soils further south.

5. *Classification.*—See Chapter II of Mr. Hadi's Manual. No botanical classification has been made: the classes given are agriculturally distinct :—

I.—Thick canes (*paunda*) are grown only for fruit.

II.—Medium canes (*ganna*) mainly for fruit but also for manufacture.

III.—Thin canes (*ukh*), grown for manufacture.

The thick canes need very high cultivation, and especially nitrogenous manure, in order to pay at all. They are therefore grown only within a carting-radius of the poudrette grounds near towns and cities*; and as the canes fetch from one to three pice each in the neighbourhood of populous centres, and are in almost unlimited demand for fruit, there is no question of using them for manufacture. The thin canes on the other hand cannot stand heavy nitrogenous manuring; when it is applied they grow rank, fall over, and yield juice with such a small proportion of crystals that it can hardly be made to set as *gur*, and in any case the *gur* is of very bad quality.

The intermediate canes are being largely abandoned owing to their liability to fungus disease.

The thin canes are particularly adapted to a country such as this, where the supply of manure is strictly limited; with good field-cultivation, such as they always receive, they pay well and leave the land in good condition for the next crop. Such attempts as have been made to force them to a higher stage of productivity have resulted in loss. Growth of the thick canes as field crops is out of the question as they will not pay at all with the small quantities of manure that are available. The movement towards growing the intermediate canes was a distinct effort towards improvement; its growth and decline are described from the statements of cultivators on page 52 of Mr. Hadi's Monograph.

Successful (*i.e.*, profitable) cane-growing is the recognized stamp of the good farmer all over those parts of the provinces where cane is grown, and the adaptation of variety to locality is very close: there is a certain amount of evidence that varieties are interchanged between different localities, and the adaptation is probably in part the result of long-continued experiments by the people themselves.

6. *New varieties.*—We have no record of new varieties being introduced into general use for manufacture. The thick fruit-canes are mostly believed to be recent introductions, but their history is not definitely known.

7. *Sports and seedlings.*—No record exists of new races arising from these causes. The local canes flower very seldom, but occasionally one or two races flower to an exceptional extent. This happened three years ago and endeavours were then made to raise seedlings, but the seed was in every instance infertile.

Mr. Hadi, who has been studying cane for many years past, has never heard of a seedling in these provinces.

8. *Other sources.*—Sugar is not obtained from other sources in these provinces. For experiments with sugar-beet see Provincial Bulletin, No. 13.

* Thick canes are grown to a very small extent for manufacture in Dehra Dun, where the land has been recently reclaimed from forest, and is in no way comparable with the old cultivated lands of the rest of the provinces.

Country spirits are made largely from *mahua* flowers, which in some parts of the provinces are used in preference to molasses, but relative prices determine the raw material used in any particular season. The single English distillery uses only molasses obtained from the sugar factory of which it forms part.

PART II.—CULTIVATION.

There is little to add to what is said in Chapter III of Mr. Hadi's Monograph.

9. *The time of planting* is governed partly by moisture conditions and partly by the time of the spring harvest. In the north, where irrigation before sowing is usually unnecessary, and in the west where canal water is available, the planting is usually finished in March before the spring harvest begins. But in the east where the spring harvest is earlier, and where the fields have to be prepared by the more laborious well-irrigation, planting is usually done after the spring harvest, *i.e*, in the end of March and in April.

16. *Preparation of sets.*—There appear to be no effective local practices. For Mr. Hayman's experiments see the reports of the Cawnpore Farm for 1903-04 and 1904-05.

Paragraph 17.—The thin canes tiller comparatively little, and have to be planted close together; about 4,000 to 5,000 canes are used per acre, or 20,000 to 25,000 tops where tops alone are planted.

Paragraph $\frac{20}{21}$.—$\frac{\text{Transplanting}}{\text{Stool planting}}$ do not appear to be practised in these provinces.

Paragraph 22.—Irrigation is needed primarily from March to June, when all natural sources are at their lowest. Whenever therefore irrigation is needed, it must be done from perennial canals or from wells. The strain that well irrigation throws on the cattle during the hottest months of the year is undoubtedly one of the obstacles to an increased acreage: the question of substituting power (such as oil-engines) is at present the subject of study. The question that has to be settled is how to adapt the power to the conditions of wells in the alluvium, which fall in and are ruined (whether hired or not) if the discharge rises above a maximum which varies from well to well. It is a matter of engineering in the first instance.

Nearly all the thin *red* canes stand immersion for considerable periods; these are grown in lowlands and along the edges of swamps. The red canes are enumerated on pages 18 *sqq.* of Mr. Hadi's Monograph. *Chin* stands immersion best of all. These canes are comparatively poor in sugar, but they often pay exceedingly well because they can be grown in places where the low situation renders irrigation unnecessary.

24. *Manuring.*—It is worth noting that the cultivators much prefer dung, poudrette, or similar manure to castor-cake, the only cake that is available locally in quantities: the latter they say leaves nothing in the soil, and this is entirely opposed to the best farming tradition of these parts, where manuring is looked on as a *quasi*-permanent improvement. (The results of residue trials in the standard experiments at Cawnpore show that continued manuring with dung has in fact a residual effect for a considerable period, while there are indications in other experiments that castor-cake is used up by the first crop).

No very definite conclusions have been drawn from the manurial experiments on cane at Cawnpore: the conditions of the experiments were such as to throw much light on other fundamental questions connected with the crop, but it is not easy to infer from them the best kind, or the most paying quantity of manure.

Paragraphs 27—32.—Such information as had been recorded up to 1901 is contained in Chapter IV of Mr. Hadi's Monograph; but the paragraphs relating to the borers have been rendered obsolete by Mr. Hayman's subsequent researches. These are detailed in the Report of the Cawnpore Farm for 1902-03 (Chapter III).

34. *Deterioration after cutting.*—Mr. Barber's statement, that delay is of comparatively little moment in the manufacture of *gur*, would not be accepted by those engaged in the industry in these provinces. The value of *gur* in the local markets depends partly on colour and partly on grain. If cane lies over

for much more than 24 hours, it is common experience that the *gur* will not solidify at all, or if it does, it shows little or no grain and fetches a very poor price. Deterioration is said by the manufacturers to be accelerated by wet and cloudy weather, and retarded by dry winds and sunshine.

Some results of deterioration tests at Rosa (Shahjahanpur District) are given in Agricultural Ledger, No. 6 of 1903. Mr. Weinberg there found that the weather was comparatively immaterial, and that deterioration became serious on the third day; but in common practice the deterioration is felt on the second day as noted above.

36. *Yield of canes per acre.*—The information available will be found on page 32 of Mr. Hadi's Monograph.

PART III.—MANUFACTURE.

37. *Manufacture of gur.*—See Chapters V and VI of Mr. Hadi's Monograph. For suggested modification see Bulletin No. 19.

Price of gur.—Hardly any substance in local markets varies more in price according to quality; and as Revenue Officials have little practical knowledge of the minute grades, the prices returned in the ordinary course are of little use for comparative purposes. About Rs. 3 per maund may be taken as the standard price received by the cultivator.

Trade.—It is not desirable to treat the trade in *gur* separately from that in sugar: the lower grade sugars are to some extent interchangeable with *gur* and the market moves as a whole. The following figures show the net trade in maunds in the different classes for the last three years. (+ shows net export) :—

	1903-04.	1904-05	1905-06.
	Mds.	Mds.	Mds.
Refined sugar	−383,700	−159,200	−527,900
Unrefined sugar	+960,500	+1,066,800	+926,600
Gur, etc.	+4,126,100	+5,036,600	+4,920,900

Refined sugars.—There is a large local production of refined sugars (*chini*, etc., *vide* Chapter IX of Mr. Hadi's Monograph). Until the last few years there has been a balance of exports, but this trade has been hit by the cheapness of imported sugars and we now import on balance. The imports are exclusively from the seaports; exports go to Bengal, the Punjab and Rajputana and Central India.

Unrefined sugars.—These include *potli*, etc. (Chapter VI of Mr. Hadi's Monograph). Low grade imported sugars compete with these to an increasing extent, but we still expect to export a million maunds on balance. The Punjab, Rajputana and Central India take almost the whole of this.

Gur, etc.—Net exports vary from four to five million maunds; there is practically no import; the chief markets are the Punjab and Rajputana and Central India; and second to these Bombay and the Central Provinces.

38. *Profit and loss.*—I must dissent from Mr. Barber's conclusion that an extension of cultivation would involve payment of cash-wages on a large scale; with the ordinary systems of labour co-operation in vogue in these provinces an additional half million acres could be cultivated under present arrangements if it were worth the people's while. The most trustworthy figures for profit and loss in these provinces are those deduced from enquiries regarding the value of canal water to the cultivator, and I extract the following from my note on the subject.

"Assuming that everything, including labour and hire of cattle, is paid for in cash, the figures are:—

	Upper Doab.	Middle Doab.	Rohilkhand.
	Rs.	Rs.	Rs.
Value of crop	115	100	114
Cost.			
	Rs. A.	Rs. A.	Rs. A.
Water rate	6 8	6 8	2 12
Rent, seed and manure	23 8	18 8	33 4
Cultivation and manufacture	52 0	56 0	58 0
Total .	82 0	81 0	94 0
Profit .	33 0	19 0	20 0

"The assumption that all labour is paid for is not of course in accordance with the facts, but it has always been realized that the data collected could be brought together for comparison only on this assumption. The more difficult task remains of eliminating the error so introduced. What we want to know is the income which the family derives from cultivation after paying out whatever has to be paid in cash or grain during the period when the crop is being got ready for the market; and to learn this we have to analyse the cost of cultivation into what has been paid out and what has not. My figures in this connection do not rest on a wide statistical basis, and are therefore liable to error of considerable magnitude, but what I give is the best conclusion I can draw from my personal knowledge and from such enquiries as I have been able to make.

"To begin with we must class the cattle, and also the implement-maker as members of the family for our present purpose. The ordinary feed of the cattle is properly regarded as part of the living expenses of the family, though if they are given extra food for especially hard work on a particular crop, that extra food must be taken into account: their depreciation is a charge which in fact is met out of the family property, whether part of the surplus laid away is devoted to buying new animals or the money is borrowed and gradually paid off. The implement-maker is paid mainly so far as my knowledge goes by a small share in the family income, a yearly or seasonal dole.

"Then as regards labour, we must deduct the cost of all the labour that is rendered by members of the family. This varies greatly in individual cases, and the estimate must necessarily be rough. We have to allow too for the common practice of labour exchange under which A works for B in the expectation that B will work for A when wanted. This system enables each cultivator to employ his labour fully, for when he has nothing to do at home, he works on some one else's land and is thereby enabled to concentrate work on his own land when there is a hurry: but A and B do not pay each other.

"Taking all these things into consideration I put the maximum expenditure at one-half of the cost of production as determined by experimenting officers. Making these adjustments the immediate outlay and the addition to the family income is shown in the following table: I have no doubt that so far as the cultivator forecasts his cost and profit, these figures are much nearer his estimate than those already given: he will think of his out-of-pocket expenses and he will think of the cash income which may be expected. I may be wrong as to the proportions of actual outlay to calculated cost of production,

but any one whose views on this point differ from mine can recalculate the table to suit the estimate which he prefers :—

	Upper Doab.	Middle Doab	Rohilkhand.
	Rs.	Rs.	Rs.
Gross income	115	100	114
OUTLAY.	Rs. A.	Rs. A.	Rs. A.
Rate	6 8	6 8	2 12
Rent, seed and manure	23 8	18 8	33 4
Cultivation	26 0	28 0	29 0
Total outlay	56 0	53 0	65 0
Net income	59 0	47 0	49 0 "

39. *Richness of juice.*—No systematic analyses have been made of the richness of the juice of different varieties. This matter awaits the appointment of an Agricultural Chemist to the Department. Dr. Leather's results reported in Agricultural Ledger No. 3 of 1897 were obtained on canes grown experimentally.

40. *Sugar-making.*—The indigenous processes are described in full detail in Mr. Hadi's Monograph. Only two factories are at work on European lines in the provinces; none are known to have failed. The managers of these factories were requested to supply so much of the information asked for as they are prepared to publish: their replies are as follows :—

Rosa factory, worked by Carew and Company, Limited. Rosa crushes cane grown in the vicinity: the Company have also extensive forest estates which are gradually being developed; they hope eventually to set up a second factory in these, but for the present the supply of cane there is not sufficient, and what is grown is made into *gŭr* and sent to Rosa for refining. The present plant can deal with 6 to 8 lakhs of maunds of cane: it is "similar to that used in Java and other places." Distillation has always been carried on and the factory is organized with this object, but the managers think that with a sufficient supply of good cane, a sugar factory could get on without this adjunct. The managers are opposed to the practice of refining *gur* as wasteful and expensive. They have occasionally imported raw sugar from Java and Mauritius when stocks were low, but it is not their usual practice.

The Cawnpore Sugar Works have two factories, one at Cawnpore and one in Bihar. The latter is a new venture for which success is hoped: the former has been worked successfully for several years without distillation, but a distillery is now contemplated in connection with it. The Cawnpore factory deals entirely with *gur* as its raw material; and has never imported raw sugar from abroad or used sugar from sources other than the cane. It declines to give any information as to its processes. The Bihar factory starts with cane grown on the Company's estates or purchased from planters.

Two factories are being erected for the ensuing season: one at Unao (12 miles from Cawnpore), the other a few yards from the boundary of the Cawnpore Agricultural station. Both, it is understood, intend to refine *gur*; they are in the hands of some of the acutest members of the Indian mercantile community of Cawnpore.

Countervailing duties.—The effect of these was to allay a panic among the manufacturers. Capital was going rapidly out of the industry, but the news of the duties checked this movement; manufacturers held on, and gradually adapted themselves to the lower range of prices instead of throwing up their business in despair. The object of the department has been steadily to show how the cost of manufacturing native sugars can be reduced, and their quality improved, so as to enable them to meet foreign sugar on equal terms, if not with a differential advantage.

The question of the direct effect of these duties on prices is practically insoluble; it is not whether they raised prices, but whether they prevented a further fall, and if so the extent to which they acted, and from the nature of the case this cannot be demonstrated by figures. Informed Indian opinion in these provinces is unanimous as to the benefits they have conferred, and such opinion is by no means an unsafe guide; but the prevention of panic and disorganization of the industry is beyond dispute.

PART IV.—IMPROVEMENTS.

The programme contemplated for these provinces is as follows :—

(1) *Varieties.*—The local varieties of each cane-tract to be valued and good varieties of other tracts tried with the object of introducing those that are better. The agricultural stations in the cane regions have been located with this object. Hitherto our experience has been that the character of the varieties changes very suddenly with changed environment, some deteriorating and others improving; there is therefore every hope of securing valuable improvements, but much detailed experimenting is necessary.

(2) *Cultivation.*—No defects have hitherto been observed except such as require a large economic change for their removal; but they will be looked for as the local staff gains experience.

(3) *Irrigation.*—The question of using engines is under examination, but as has been explained there are considerable preliminary difficulties to be surmounted.

(4) *Manufacture.*—From what has been said above, it will be seen that the Cawnpore mercantile community are looking at the present time to refining *gur* by European methods as a profitable development: they are by no means incompetent judges of commercial possibilities. The fact that the amount of grain is a controlling factor in the price of *gur* ensures that the *gur* makers will do their best to secure it; *gur* making moreover is essentially a domestic industry, and it is difficult to influence it except through the market. Factories dealing with the cane have to face serious difficulties of organization where the growers are numerous and each plot is small—the usual conditions in the provinces. The methods of making unrefined sugar described in Bulletin No. 19 are beginning to be adopted; and improved methods of refining this produce are being worked out. These developments have had to be engineered without the control of constant analysis, a condition which it is hoped will soon be remedied.*

I believe myself that in these provinces there is room for all three methods, European factories working from the cane, European refineries working on *gur*, and small installation working up sugar by improved native methods; while finally the great bulk of the produce will for many years to come be consumed as *gur* by our numerous and conservative population.

Government aid must be given (*a*) by experiment with varieties and issue of seed-canes when success has been attained; (*b*) by demonstrations of improvement on native methods; that is by the ordinary methods of Government action. I can see no useful opening for subsidies to private factories.

Crushing mills.—If as is suggested above the initial processes of manufacture are likely to remain in the hands of the cultivators and small manufacturers, the most urgent need is the provision of efficient crushing mills; this would probably raise the outturn of raw sugar by at least 10 per cent. without the cultivation of an additional acre. I have indicated elsewhere that the best hope of this improvement lies in the supply of mills being taken up by responsible capitalists; it is very difficult to see what Government can do in the matter and any suggestions on this point will be most welcome.

W. H. MORELAND, C.I.E., I.C.S.,
Director of Agriculture.

* A recent analysis by Dr. Lehmann showed that a sample of semi-refined sugar (*khand*) made by Mr. Hadi contained 98·75 per cent. of sucrose, and a refined sugar (*ganá*) 99·80 per cent.

Bengal.

Part I.

Introductory.

1. *Introductory.*—This report refers to the Province of Bengal as constituted after the partition, comprising an area of 115,787 square miles, of which 39,115,100 acres are under cultivation.

2. *Climate.*—Statement, showing the normal rainfall, month by month, n the Province and the normal mean temperature will be found appended, (*vide* Appendices I and II.)

3. *The age of sugarcane cultivation in India.*—Reference is made to the cultivation of sugarcane in India in many ancient writings, which go back as far as the Institutes of Manu. In several parts of Bengal, the cultivation of sugarcane is of comparatively recent growth, *e.g*, in Chota Nagpur and Orissa, where it has spread after the establishment of irrigation facilities. In Champaran, sugarcane is supposed to have been introduced by immigrant *raiyats* from Azamgarh and Gorakhpur (neighbouring districts of the United Provinces) about a century ago.

4. (*a*) *Extent of cultivation.*—For the quinquennial period ending 1904-05, the area under sugarcane in the whole of India has been estimated at 2,404,000 acres and in Bengal at 457,200 acres, so that the sugarcane area in this Province is 19 02 per cent. of the total sugarcane area of India. In the Province itself, it comprises 1·77 per cent. of the total cultivated area. The figures given in the following statement will show at a glance the extent and distribution of the cultivation :—

Area under Sugarcane.

Name of tract.	Total area of tract.	Area in 1890–91.	Average of five years 1900–05.	Average of five years 1895–1900.	Average of five years 1900–05.	Area in 1905–06.	Area in 1906–07.
	Acres.	Acres.	Acres	Acres.	Acres.	Acres.	Acres.
Deltaic tracts . . .	20,108,103	215,800	182,500	130,900	123,000	123,800	120,700
South Bihar . . .	7,142,400	79,000	118,100	66,800	80,400	84,800	90,300
North Bihar . . .	8,056,216	97,200	152,300	117,400	77,600	87,100	83 900
Bhagalpur . . .	12,655,633	97,700	98,200	100 200	93,600	86,100	61,900
Orissa	8,795,488	23,200	19,600	17,700	16,200	15,200	14,300
Chota Nagpur . . .	17,341,640	211,500	113,800	115,400	66,400	52,100	53,100
Total	74,103,179	755,000	682,500	578,400	457,200	449,100	423,500

The areas shown for the Deltaic tracts and for Chota Nagpur for the year 1890-91 appear to be open to doubt. Bihar, comprising North and South Bihar and Bhagalpur, is the most important sugarcane growing tract of this Province, and there can be no doubt that the sugarcane industry is being revived here consequent upon the decline of indigo.

(*b*) *Character of cultivation.*—Sugarcane cultivation is for the most part undertaken in Bengal wherever water is available. In certain parts of North Bihar, it is grown without irrigation. Rotation is practised as a rule, and the crop is grown generally in small plots of land by *raiyats*. Among planters, large blocks, extending over several acres, are now being put down under the crop.

(*c*) *Soils.*—Nearly all kinds of soil answer for growing sugarcane, from the Sedentary Archaean soils of the Chota Nagpur Division to the old alluvium of Bihar and the new alluvium of Eastern Bengal. The best canes grow at the junction of old and new alluvia, on the sides of streams and rivulets These are clay loams, which are rich in mineral matter. Sugarcane is to be found on all kinds of soils, having an admixture of clay and loam in different proportions, and also on *diara* lands situated above the inundation level.

5. *Varieties of cane grown.*—Sugarcane in Bengal may conveniently be divided into two classes, *viz.*, (*i*) thick canes with much juice but with soft rinds, generally delicate and liable to be attacked by wild animals, and (*ii*) thin canes with hard rinds, not so liable to disease and not as easily attacked by wild animals

(*i*) The chief canes which come under the first class are:—

(*a*) *Bombai.*—A large-sized red cane, rind soft, juice abundant, rich in sugar, but delicate, and specially liable to disease. Cannot stand effects of flood and excessive rainfall. For these reasons its cultivation is dying out in some districts.

(*b*) *Samshara.*—A large-sized cane; a great favourite in the deltaic area; rind of a pale yellowish-white colour, fairly soft; produces a light-coloured *rab*, which is much prized by confectioners.

(*c*) *Kajli or Kali.*—A fairly large-sized and hardy cane with a purple colour; an early variety. Yields *gur* of an inferior quality, and therefore cultivated on a small scale; but its *gur* is reputed to contain some medicinal properties.

(*d*) *Kantari.*—A yellowish cane resembling *Samshara*, much used for chewing, and commonly grown in Orissa.

(*e*) *Paundia.*—A favourite chewing variety, thin-skinned and thicker than *Samshara*.

(*f*) *Puri or Koori.*—A softer but thinner cane than *Samshara*, which it resembles in colour. It is said to be one of the richest in sugar of all the Bengal varieties, and to produce a better-coloured *rab* even than *Samshara*, but it is liable to break readily and hence is not much cultivated. It is first of a more or less reddish colour, and it then becomes yellow with brownish spots.

(*g*) *Dhalsunder or Dholi.*—A moderately soft cane of reddish green colour. It is thinner and harder than *Samshara*, is not so easily damaged by water-logging as other soft canes, and is cultivated largely in East Bengal.

(*h*) *White Bombai.*—A large-sized cane, but grown, like the red *Bombai*, only to a limited extent; liable to disease.

(*i*) *Ruppa.*—A soft-rinded cane of a yellowish-white colour, showing red stripes when ripe.

(*j*) *Bangla.*—Very much like *Samshara*. The rind is soft and thin; canes are rich in juice and much used for chewing.

(*ii*) Among canes, coming under the second class, may be mentioned the following:—

(*a*) *Mango.*—A very popular variety in Bihar; a short and thick-skinned cane, colour green when young, but changing to a reddish-yellow colour when ripe; resists drought, but is damaged by water-logging. Good *rab* is produced from this cane. Its percentage of sugar to juice is large.

(*b*) *Bhurli.*—Another common variety of Bihar, somewhat similar to *Mango* in appearance, though a little thicker.

(*c*) *Pansahi.*—A whitish-yellow cane, thinner than the above varieties, largely cultivated in Bihar and appreciated as a chewing cane. Colour whitish-yellow.

(*d*) *Barukha.*—A greenish cane, very similar to *Pansahi*, grown largely in Bihar, and appreciated for chewing. It ripens early in November.

(*e*) *Shaori.*—A tall, rather thin cane; yellowish-green in colour changing to reddish-brown when ripe. Grows in low lands, and can stand water-logging.

(*f*) *Reora.*—Supposed among thin hard-rinded varieties to be second only to *Mango* in the richness of its sugar.

Rab and *gur* are made from this cane; colour yellow changing to a grey when ripe; not suited to heavy soils and cannot stand water-logging.

(*g*) *Ketari or Chinia.*—A thin small cane, with decidedly long nodes; fairly hardy, yellowish colour, early variety; gets brownish-red when ripe.

(*h*) *Hemja.*—Very similar to *Mango*; of a greenish colour, and short.

(*i*) *Poraich.*—A yellow cane, thinner than *Mango*; stands water and is grown generally on low lands.

(*j*) *Ikri.*—A tall thin cane, yellowish in colour, found in East Bengal; endures submersion in water.

(*k*) *Khari.*—A thin, very hardy variety, can resist drought to some extent. Being very hard and thick-skinned, it is not much destroyed by white-ants. Yields good sugar.

(*l*) *Khagri*—This cane is also found in East Bengal and, like the *Ikri*, stands prolonged submersion. It is reported that it can thrive even in six feet of standing water for about three months. The *gur* is of inferior quality and the outturn is poor. In this, as in the *Ikri* cane, it is said that the amount of crystallised sugar is very small.

(*m*) *Pachmahi*—A rather thin cane found in Bihar; can stand water-logging to some extent.

In the above lists, it is possible, if not probable, that a difference of name does not always indicate a distinct variety. The Bengal canes still require systematic identification and classification.

A wild cane is reported from Orissa, which is known locally as *anakhu*, *bahya* or *kusari*. The plant looks like *juwar* (*Sorghum andropogon*); the stems are slightly sweetish. The juice is used in the treatment of insanity (hence called commonly "mad" sugarcane), and of brain and eye diseases. It is also sometimes given to cattle as fodder.

6. *Recorded introduction of new varieties.*—Striped Mauritius, Otaheite and Bourbon pink-coloured canes have been introduced by some planters. They are said to be very liable to disease and are very delicate, and therefore not popular with *raiyats*. It is reported that the *Samshara* variety of Bengal has been introduced into the West Indies. Some cuttings were taken also to Java some years ago.

7. "*Sports*" *and seedling canes.*—Instances of *sports* and of canes raised from seedlings are not common in Bengal. There is reported to be in some districts of Western Bengal a hardy cane, locally known as *Uri*, which seeds freely. Should a cane flower, it is considered a bad omen by the *raiyat*, who generally cuts off the flowers, as soon as they appear. From Sambalpur, it is also reported that a variety locally known as *Kihana Busari* is grown from seed.* It is a very poor variety and resembles *juwar* in appearance.

8. (*a*) *Other sources of sugar and spirit.*—Besides cane, the other sources of sugar are the date palm (*Phœnix sylvestris*) and the palmyra palm (*Borassus flabelliformis*). Date sugar is largely made in the district of Jessore.

Country spirit is manufactured from *Mahua* (*Bassia latifolia*), from *gur* or *molasses*, from *Mahua* and *gur* mixed, from rice, from the date palm and the palmyra palm.

(*b*) *Experiments with beet and sorghums*—Some experiments have been carried out on a small scale by private individuals from time to time, but no recorded results are forthcoming.

Part II.

Cultivation.

9. *Planting and reaping seasons.*—Sugarcane harvesting and sugarcane planting can proceed for eight months in the year, *viz.*, from September to April, but the best time for harvesting is from December to February, and this is also the best time for planting. The early varieties, which as a rule are not important, are planted in November and December, and reaped about the same time the following year. When irrigation facilities are scanty, sowings are generally postponed to April. The crop occupies the ground as a rule from 8 to 12 months.

From Sambalpur, it is reported that when canes are grown from seed, the sowing takes place in June and the harvesting comes on late in March or April.

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* This report requires verification

10. *Rotations and mixed cropping.*—Sugarcane is considered an exhausting crop, and is therefore not grown on the same field in two successive years. Some of the common rotations adopted are as follows:—

(*i*) Sugarcane comes after any of the following crops—(*a*) pulse crops, (*b*) potatoes, (*c*) *aus* paddy, (*d*) wheat or barley, (*e*) mustard, and is then followed by *aus* paddy.

(*ii*) First year sugarcane, second a *bhadvi* crop, after which a cold-weather crop follows; third year a fallow.

Very frequently, sugarcane follows *aus* paddy. The alternation with pulse crops is also common. In factories, indigo forms a good rotation with sugarcane. From Lohardaga, however, it is reported that sometimes sugarcane is grown for three successive seasons on the same land, after which some inferior crops are taken, *e.g.*, *sarguja* (Guizotia abyssinica), for a year to enable the soil to recoup its lost fertility. In Bihar, peas are sometimes grown with sugarcane. When sugarcane follows pulses, the latter are often grown as catch-crops following autumn paddy. After the harvesting of the catch-crops, the land is prepared for sugarcane *Birhi* or *urid* (*Phaseolus radiatus*) is a favourite catch-crop. Turmeric and potherbs are also used as catch-crops.

The borders and fringes of cane-fields are sown in many places with *Patua* (*Hibiscus cannabinus*), *dhaincha* (*Sesbania aculeata*), *arhar* (*Cajanus Indicus*), *juwar* (*Sorghum andropogon*). Chillies are also sometimes seen on the outskirts.

Green manuring for sugarcane is practically unknown in Bengal. In some places, however, during the rains the field is surrounded with low *bunds* and allowed to remain in that state till August or September, when advantage is taken of a heavy shower to plough and harrow the field and thus destroy the weeds, which, after rotting serve as green manure.

11. *Ratooning.*—*Ratooning* is not largely carried on in Bengal, as *ratooned* canes are said by the *raiyats* to be more liable to fungoidal diseases and insect pests than annual canes, and to exhaust the soil. Where practised, the stools are generally allowed to grow for the second year. But *ratooning* for two, or sometimes three crops is not unknown. It is practised with some varieties in deltaic Bengal and in Bihar. From Dacca, it is reported that after the crop has been harvested, the fields are covered with virgin earth taken from the bottom of the creek below, and the shoots allowed to grow, this system being carried on for two years.

Ratooning experiments made by the Department of Agriculture on the Burdwan and Sibpur Farms with the variety known as *khari* disclosed the following results:—

BURDWAN FARM.

STATEMENT I.

Year.	Outturn of *gur* per acre. lbs.
1887-88	5,727
1888-89	7,109
1889-90	7,837
1890-91	10,291
1891-92	8,072
1892-93	7,875
1893-94	3,333
1894-95	1,419

SIBPUR FARM.

STATEMENT II.

Year.	Outturn of *gur* per acre. lbs.
1891-92	4,169
1892-93	5,078
1893-94	4,555
1894-95	4,742
1895-96	3,733
1896-97	1,458

12. *Preparation of the land.*—When sugarcane follows a *bhadvi* crop, the preparation of the land commences after the harvesting of the *bhadvi* crop. The *raiyats* believe in thoroughly pulverizing the soil, and so the land is repeatedly ploughed and exposed to the sun. The implements used generally are the ordinary country plough and the country harrow (a ladder made of bamboo or a beam of wood). The number of ploughings vary a great deal according to the nature of the soil and the skill of cultivators. From five up to sixteen ploughings and cross-ploughings are given in different places with three or four or more harrowings. Hand hoeing with the *kodali* is also done in many districts.

When sugarcane follows potatoes, the land is almost ready for the reception of the cuttings without any further preparation. Two or three ploughings and harrowings are all that are necessary. When fallowing is adopted in the rainy season, the land is ploughed, manured and weeded till the end of the rains, the frequency of ploughing depending a great deal on the leisure of the cultivator, whose hands remain more or less full of other work during this period. Then after a rest, the land is again ploughed at intervals up to the time of planting. If the weather, before the planting takes place, has been particularly dry, the field is irrigated and then ploughed and levelled before sowing. When the ploughings are going on, the fields are manured, the commonest manures used being cowdung, pigdung, horsedung, sweepings, ashes, and mud from old tanks. Sheep folding is also practised in some places. *Seet* or indigo refuse is used by planters. When cowdung is used, the ordinary rate amounts to about 100 maunds per acre. Manure is also applied at the time of sowing, and in some places at the time of earthing up. Oilcakes are generally used during earthing. In some places on the banks of the Brahmaputra, it is reported that when it is intended to grow sugarcane on land that is too sandy for this crop, or that has been exhausted by repeated cropping, the fertility of the land is first restored by laying it down in *Ulu* grass (*Saccharum cylindricum*). The *Ulu* is harvested in November, and immediately after, the field is ploughed and manured, and the land is got ready by February.

13 to 18. (*a*) *Planting.*—In some of the more advanced sugar districts in Bengal, the beds in which sugarcane is planted are so arranged as to serve a double purpose, *viz.*, to give facility for irrigation and to remove the rain water from the field as speedily as possible. This is done first by dividing the field into a number of long strips by broad trenches or channels drawn from the top to the bottom of the field at intervals of some 40 feet. A number of smaller water-channels are now drawn across the field, all parallel to one another and about 7 or 8 feet apart from each other. The whole field, in this way is divided into a number of small beds, each 40 feet by 7 feet. The water-channels are all made by the *kodali*. Next, with a good plough and a pair of steady bullocks, parallel furrows are drawn across these beds at intervals of about 22 inches. Finely-powdered oilcake is spread at the bottom of these furrows. Water is then poured from an earthen vessel into them, and in the mud thus made, the cane cuttings are placed lengthwise, leaving an empty space of about 9 inches between each. The cuttings are then covered with a layer of earth of about 3 inches thick. In some places, after the water-channels have been made, holes are dug in parallel lines at intervals of about 24 inches and at a distance of about 18 inches from one another in the line. Cuttings are put into these holes, one in each, with a little oilcake and water, and covered with earth.

A very common practice, and one largely followed in Behar, is to plant the cuttings of cane behind the plough. One plough goes in front of a second in the same furrow, which is thus made deeper. A man follows the plough with cane cuttings, which he lays flat over the bed of the furrows, allowing about 6 to 9 inches of ground between every two cuttings, and presses down as he walks along. The fields are then levelled with a beam. In some places, ridges and furrows are made. For this purpose, a third plough sometimes follows and makes a furrow a little on one side and covers up the cutting in the preceding furrow with a layer of soil about 6 inches deep. The *kodali* is also used for making ridges and furrows. The cuttings are planted in the furrows, and as the plants grow up, they are earthed till the furrows become ridges and the ridges furrows.

The mode of planting known as the Mauritius system, which has been strongly recommended by Messrs. Thomson and Mylne of Behesa, is not unknown in Bengal.

Among Bihar planters, the trenching system is commonly adopted.

In the case of ordinary cultivators, the depth at which the sets are placed varies from 2 to 6 inches generally, and the distance at which the sets are placed, from 6 to 12 inches: while the distance of the rows apart ranges from 9 to 24 inches.

(*b*) *The source from which the seed is obtained.*—It is a very common practice to separate the "tops" while the crop is being harvested, and to use them for sowing the following season's crop. This is done both with annual and *ratooned* canes. Generally, a part of the crop is left standing on the ground, and reserved for sowing later on, after the main harvesting is completed. In such cases, the plants intended for sowing are left untouched for a month and more. They are then cut into small lengths, which are usually kept in a pit covered with mud and straw for three or four days before sowing.

The practice of bringing sets from a distance is not general among *raiyats*, but it finds favour with planters.

(*c*) *The part of the cane used for planting.*—As a rule, the top portion of the cane is used for cuttings. It is the opinion of many *raiyats* that more than a foot of the stem from the top end should be cut into sets, as the buds lower down do not produce healthy plants. The whole cane is also cut up into sets. In this case, the lower end of the rooting portion of the cane is rejected. To a limited extent, the whole cane, without being cut, is sown in shallow trenches.

(*d*) *The actual preparation of the sets for planting.*—There are three methods of preparing sets for planting.

The first process consists of putting in sets, pell mell into a small pit in three or four layers with rich earth or pond mud between the layers. The top layer is covered with earth and straw. The cuttings are watered regularly at intervals of three or four days and are ready for planting in about 10 or 12 days. Sometimes, the layers of soil between the cuttings are done away with, and ashes are only put above and below the cuttings, which are covered with a layer of earth.

The second system is more elaborate, being followed generally when the cuttings are to be kept for a longer time before sowing. Under this system, the lower end of the cuttings is buried vertically about two inches deep into a muddy layer of earth, and then covered with straw. Watering is necessary when the mud gets dry. Sprouting is generally slow in this case, and cuttings may be kept buried for nearly two months.

A third way of preparing sets is to keep them buried in moist sand for about a week.

No pickling is done by *raiayts*.

The number of nodes in a set varies from two to five.

(*e*) *The number of sets per acre.*—Among cultivators, as a rule, the number varies from 12,000 to 16,000. But in many places 20,000 to 30,000 cuttings are used, and in some places even a larger number is said to be used for planting, under the erroneous idea that the more the cuttings, the more will be the number of canes produced, and the greater the quantity of juice and *gur* obtained.

The sets are ordinarily about 6 inches long.

(*f*) *The mode of planting.*—This has already been described in a previous paragraph.

19. *Supplying vacancies.*—In many places, especially where thick sowing is done, vacancies are not filled in. In other places, extra sets are kept in pits for filling up gaps, as soon as they are disclosed—generally after three weeks or so. Sometimes even a month and a half elapses before fresh sets are put into the gaps.

20. *Seedbed and Nursery.*—No such practice is followed in Bengal.

21. *Stool planting.*—No such practice in known.

22. *Irrigation and Drainage.*—The advantages of these two operations are well known to Bengal *raiyats*, who, as a rule, select soils where there are means of irrigation, *e.g.*, canals, tanks, streams and wells. In some parts of North

Bihar, no artificial irrigation is resorted to, especially in soils which are highly retentive of moisture and where the rainfall itself is considered to be quite sufficient for the crops.

23. *Cultivation.*—The number of weedings and hoeings has a wide range. In some places, only two or three weedings and as many heeings are given, and in others, three or four weedings and as much as 10 or 12 hoeings are found necessary. The weeding is generally done with the hand hoe or *khurpi*, and the hoeing with the hand spade or *kodali*. It is a common practice, seen after planting, to remove the earth on either side of the cuttings with an iron hook or small piece of bamboo, then with the fingers to remove the earth round the little sprouts, and thus expose them to the sun and air for a couple of days and then to earth them up. At the time of earthing, manure is often applied.

The practice of preventing evaporation by laying a mulch of grass on the land has not been reported.

24 *Manuring.*—The practice of manuring with oilcake when the plants are being earthed up has already been referred to. It is a common practice in Lower Bengal to apply half of this manure at the time of sowing and half when the plants have attained a height of about 1 to 3 feet. The amount of oilcake applied is about 20 to 30 maunds per acre, and this is in addition to the cowdung already applied at the time of preparing the land.

The oilcakes chiefly used are mustard, castor, linseed and gingelly. A statement will be found in the appendix (Appendix III) showing the different kinds available in Bengal and their prices. The prices quoted are for Bihar, but they may be taken as more or less representative of Bengal. Samples of cakes numbered (1) to (4) have been analysed by the Agricultural Chemist to the Government of India, and the results of his analyses are given in the statement.

No statistics are forthcoming regarding the available supply of oilcakes. A collection of these cakes is being made, and will be placed before the Conference at Cawnpur.

Burning the dead leaves and using the ashes for manure is practised, but almost always, the leaves are utilized, in the first instance, for boiling the juice.

From Bihar, it is reported that a prejudice exists against the use of cowdung, as it is supposed to deteriorate the quality of the *gur*. Oilcakes are often said to make the colour of the *gur* dark.

The results of manurial experiments conducted by the Department are given below :—

BURDWAN FARM.

STATEMENT I.

Manure and quantity per acre		OUTTURN OF GUR PER ACRE.					
		1888-89.	1889-90	1890-91	1891-92.	1892-93.	1893-94.
	Mds.	lbs	lbs	lbs	lbs.	lbs.	lbs.
Super	7 5	..	...	...	3,784	3,579	2.092
Castor-cake	11 2						
Castor-cake	12	3,877	4,033	6,372	6,788	6,512	3,576
Saltpetre	3·1	...	...	...	4,443	4,196	4,551
Super	9						
Gypsum	3						
Bonemeal	9	...	...	...	5,184	4,937	4,838
Saltpetre	3·1						
Super	3						
Cowdung	300	...	...	...	3,950	3,703	4,826
Bonemeal	21	...	...	...	4,566	4,448	3,394
Saltpetre	3 1						
Castor-cake	30	5,454	3,951	7,36 6	6,912	6,665	5,239
Bonemeal	15						
Bonemeal	45	4,190	2,224	6,152	4,699	4,319	2,086
Unmanured	...	3,021	789	2,462	1,320	failed.	

STATEMENT II.

Manure and quantity per acre.		Outturn of *gur* per acre.				
		1896-97.	1897-98.	1898-99	1899-1900	1900-01.
	Mds.	lbs.	lbs.	lbs.	lbs	lbs.
Cowdung	607·6	5,148	3,924	2,691	2,734	3,006
Bonemeal	89·4	4,966	3,783	3,693	3,714	3,624
Cowdung	303·8	4,821	3,990	3,072	3,199	3,690
Bonemeal	44·7					
Cowdung	303·8	5,136	3,618	3,603	3,636	3,039
Super	59·3					

STATEMENT III.

Manure and quantity per acre.		Outturn of *gur* per acre.
	Mds.	lbs.
Cowdung	288	4,746
Cowdung	192	6,372
Castor-cake	9	
Cowdung	192	5,808
Rape-cake	12	
Castor-cake	31	6,180
Rape-cake	36	5,664
Castor-cake	24	6,444
Saltpetre	8	
Rape-cake	24	5,762
Saltpetre	8	
Bonemeal	49	6,564
Saltpetre	8	

DUMRAON FARM.

STATEMENT IV

Manure applied.	Quantity of manure per acre.	Outturn of *gur* per acre.	
		1900-01.	1901-02.
	Mds.	lbs.	lbs.
Cowdung	90 6	1,645	2,600
Cowdung	45·3	1,725	3,300
Bonemeal	30 4		
Cowdung	45·3	1,845	3,715
Castor-cake	4·7		
Castor-cake	9·4	1,905	3,005
Town sweepings	2,337·1	1,660	2,065
Cowdung	45·3	2,046	2,695
Super	13·0		
No manure	.....	1,476	1,940

25. *Treatment of the canes during growth.*—The operation of tying up a number of plants with the mature leaves is more generally adopted in Lower Bengal than in Bihar, and more commonly with thick and tall canes than with thin and short canes. When this operation is first undertaken, the dead leaves

are stripped off. This practice is not only a protection against high winds, against the sun's rays and against ravages of wild animals, but it lets in more air and is said to induce more vigorous growth and to increase the amount of sugar. A few days after the single leaves are tied up, groups of canes of 5, 10 or 15 are tied together in the same way. This same process is repeated from time to time as fresh leaves make their appearance. Bamboo supports are also frequently used.

Fences of bamboos or of thorny jungly plants are sometimes to be seen round sugarcane fields, but as a rule very little care is taken by the Bengal *raiyat* to protect his crop against wild animals.

26. *Treatment of the fields preparatory to reaping the canes.*—In some places, especially in Bihar, the field is irrigated a week or fortnight before reaping, and this is supposed to increase the quantity of *gur*. In Lower Bengal, on the other hand, water is withheld before harvesting, as watering at this stage is said to increase the amount of juice in the cane at the expense of sugar.

27 and 28. *Diseases, etc., affecting the sets after planting.*—Most damage is probably done by white-ants and jackals.

29 to 32. *Diseases, etc.*—The only scientific investigations, in respect of sugarcane diseases in Bengal hitherto published are contained in the Bengal Department of Land Records and Agriculture Bulletin, No. 7 of 1900, the Agricultural Ledger No. 5 of 1901, and the memoirs of the Department of Agriculture in India, Vol. I, No. 3 "Fungus Diseases of sugarcane in Bengal," to which reference is invited.

Out of a total of 79 sets of diseased canes from 22 districts of Bengal (as it stood before the Partition) examined by Captain A. T. Gage in 1900, in only 10 was *Colletotrichum falcatum*, alone found. In seven, *Xyleborus* alone was found. In three, nothing definite was discovered. One showed the effects evidently of the grub of some moth The remainder showed *Colletotrichum falcatum*, and *Xyleborus* associated with the distinctive effects on the tissues peculiar to each in varying degrees. The disease percentages given varied from 1 to 75. The average was about 23·5. The soil, in most cases, was described as sandy clay. The cane, in all cases, was reported to be propagated either from tops or cuttings.

33. *Reaping—Time of cutting the canes.*—After the Winter harvest is thoroughly complete, the *raiyats* generally turn their attention to the cutting of sugarcane. Many chew a cane or two before cutting to find out whether the crop is fully ripe or not. The condition of the leaves, and the colour and hardness of the stem are other tests But the crop has often to remain on the ground after it is fully ripe owing to the difficulty of getting mills in proper time. There is an idea among cultivators that sugarcane does not become sweet before October.

34. *Deterioration after cutting.*—Among cultivators, no time intervenes between the cutting and crushing. The cane press is set up close to the cane field, and as soon as the canes are cut, they are brought to the press. In the case of large factories, considerable delay must often occur.

35. *Mode of cutting the canes.*—In this Province, the practice is to make only one cutting close to the ground with the spade. When there are ridges, the canes are cut just at the bottom of the ridges. No experiments have been made with cane cutting machines.

36. *Yield per acre in canes.*—From Bihar, it is reported that from 24,000 lbs. to 34,000 lbs. of cane are obtained from the thinner varieties, and about 40,000 lbs. from the thicker varieties.

Part III.

Manufacture.

37. *Manufacture of jaggery or gur.*—For the extraction of the juice four different forms of country mills are still to be seen, but they are being rapidly superseded by the Behcea sugarcane mills and by country mills made more or less after the pattern of the Behcea mill:—

(1) The first, called *chaki*, consists of two horizontal wooden rollers furnished with screws fitting into each other. This machine is worked by two men, sitting at either end, who turn the spokes attached to one of the ends of each of the rollers. A third man feeds it with canes, and a fourth man, sitting opposite to him, receives the half-crushed canes and gives them back to the

third man. The canes must be passed and repassed several times, and even when this is done, a large percentage of the juice escapes extraction.

(2) The second consists of two stout wooden rollers placed vertically with a lever attached as in the Beheea mill, and is worked by a pair of bullocks. Three men are required to work this mill—one to drive the bullocks, another to feed the mill with cane, and a third to assist him, as in case of (1). This mills seems to be copied from a Bombay pattern.

(3) The third form is the *kolhu* or *ghani*, and acts on the prineiple of a mortar and pestle, but instead of the up-and-down motion of an ordinary pestle, in the *kolhu*, the pestle is rolled against the sides of the mortar by a lever attached to it. In olden times these mills were made of stone.

The price of the Beheea mill is generally too high for the individual *raiyat*. Such mills are therefore generally purchased by *mahajans* who let them out on hire at rates varying from 6 annas to Re. 1 per day.

The number of men required to make *gur* by the country mill, and the arrangements necessary for the operations, are described below:—

(*a*) Two men to cut the canes, to remove the tops and leaves and to carry the canes to where the mill is working.
(*b*) Four men to work the *chakki* a whole day, two men working at a time.
(*c*) One man to feed the mill with canes.
(*d*) One man to receive the canes and give them to the feeder to pass them again through the mill.
(*e*) Two men to attend to juice boiling.
(*f*) One man to attend the furnace.

About three or four maunds of *gur* may be made in this way daily.

The boiling of the juice into *gur*, as conducted in Lower Bengal, is a cumbrous operation, and compares very unfavourably with the practice followed in Bihar. Both in making the *gur* and in refining it into sugar, the Bihar *raiyats* are far ahead of the cultivators of Lower Bengal. A plot of ground is selected as close to the field as possible, and in this a hole is dug out about 10 feet long, 4 feet broad, and 5 feet deep. Over this is placed a wooden or bamboo frame-work lined with earth for the reception of two series of pots. The hole is open at both ends, through one of which the furnace is fed with fuel, and through the other the ashes are removed from time to time. The fuel used consists of cane leaves and dried *begass* or cane stalks from which juice has been extracted. The number of pots used is generally twelve. The juice, as it begins to thicken, is brought from one pot to another, till it finds its way to the last two pots nearest to the furnace mouth. In these two pots, or, in some places, in one of them, the juice is allowed to attain the consistency of treacle, when it is removed to large earthen vessels capable of holding from two to three maunds of *gur* each. This is what is known as *ráb*, which has only a semi-solid consistency.

The mode of pressing and of manufacturing *gur*, as given above, is dying out now. Roller mills are very common, and the round shallow evaporating pan is used for boiling. When *gur* is made, instead of *ráb*, the boiling is continued a little longer, and when the thickened juice is taken off the furnace, it is stirred for a while and then poured into circular holes dug in the ground, which serve as moulds, the bottom and sides being lined with split bamboo. This is called *chaki gur*. It is quite solid. When not sold immediately, it is packed in gunny bags and kept inside *bhusa* (chaff) to prevent the draining of the molasses as much as possible The exact time for taking the juice off the fire is determined by taking a little of the syrup between the first finger and the thumb, and then drawing them apart, so that the syrup is drawn out into a fine thread. When this thread can be drawn out to about an inch or so, the exact time for removing the juice is supposed to have been reached. The cultivators, as a rule, take no particular care with the manufacture. The juice is very rarely strained, as it leads to an ultimate diminution in the output. The scum also is not always wholly removed for the same reason. No wood is used in boiling.

For the first day or two, the *trash* is used as fuel, and when the *begass* is sufficiently dry, dead leaves are no further required. It is the custom in some places to give away the leaves as part of the wages to those that strip and prepare the canes for the mill. If any *trash* is left over, it is used as manure. Liming is sometimes resorted to, in order to neutralise the acidity

of the juice caused by the canes being in bad condition, or by the extraction of the juice or the boiling being delayed. Milk diluted with water is often added to the boiling juice to assist coagulation, and to bring the scum to the surface. A little castor emulsion, obtained by crushing the seeds with the pestle and mortar, is sometimes added to the half boiled juice when owing to the bad quality of the canes, the juice does not thicken quickly.

The price of *gur* varies from Rs. 3 to Rs. 5-8-0 per maund. The average may be taken as Rs. 4 per maund.

38. *Profit and loss on sugarcane cultivation.*—This must necessarily vary in different parts of the Province. About as full a balance sheet as possible is given below, representing the profit and loss worked out for the Burdwan District, which may be taken as representative of Lower Bengal. The figures are for a bigha of land which is one-third of a standard acre :—

Cost of Cultivation per bigha (one-third of a standard acre).

		Rs.	A.	P.
Hoeing, 8 men		2	0	0
Ploughing, 8 times		3	0	0
40 Loads of dung		2	8	0
To apply the same		1	8	0
To make the water channels, 4 men		1	0	0
To make the furrows, 1 plough		0	6	0
2½ *lahans* of sugarcane tops		10	0	0
Planting, 8 men		2	0	0
Watering twice, 4 men each time		2	0	0
Irrigation, 2 men		0	8	0
1st hoeing, 5 men		1	4	0
Irrigation, 2 men		0	8	0
2nd hoeing, 4 men		1	0	0
Baisakh	Irrigation, 2 men	0	8	0
	Hoeing, 4 men	1	0	0
	Irrigation, 2 men	0	8	0
	Hoeing, 4 men	1	0	0
Jaistya	Hoeing, 4 men	1	0	0
Ashar	Hoeing, twice	2	0	0
Sravan	2 Hoeings	2	0	0
	4 maunds of oil-cake	4	8	0
	Trimming the leaves 4 men	1	0	0
Bhadra	Hoeing, once	1	0	0
	Trimming the leaves	2	0	0
Aswin	Hoeing once	1	0	0
	Trimming the leaves	1	0	0
Kartick	Hoeing, once	1	0	0
Agrahayan	Irrigation	0	8	0
	Hoeing	1	0	0
	4 maunds of oil cake at the time of planting	4	8	0
		53	2	0

i.e, Rs. 159-6 per acre.

		Rs.	A.	P.		Rs.	A.	P.
Gur-making	5 men to cut and strip canes	1	4	0	per day.			
	1 man attends to the furnace	0	4	0				
	1 man boils the juice	0	4	0				
	1 feeds the mill	0	4	0				
	1 man drives the bullock	0	4	0				
	4 bullocks to drive the mill	1	0	0				
	The work is extended over 4 days					18	0	0
	Fuel					0	8	0
	Hire of the mill and a pan					4	0	0
	Rent					4	0	0
				Total		74	10	0

i.e., Rs. 228-14 per acre.

Outturn	24 maunds of *gur*	96	0	0
	Sugarcane tops	18	0	0
	Total	114	0	0

i.e., Rs. 342 per acre.
Profit = Rs. 118-2 per acre.

In Bihar, Chota Nagpur and Orissa, where less manure is used, and where the cultivation is much less elaborate, and labour cheaper, the cost does not exceed Rs. 80 per acre. The average yield of *gur* amounts to 35 maunds per acre, which, taken at the rate of Rs. 4 per maund, would give a return of Rs. 140 per acre. It must be remembered that much of the labour employed both in cultivation and in the manufacture of *gur* is supplied by the cultivator's own family, and the net profit is really, therefore, greater than these figures indicate.

39. *Character and richness of the juice* (*a*).—The percentage amounts of cane sugar and of glucose found by Dr. Leather in the juice of the varieties of cane grown at Dumraon are given in the statement below :—

Six Varieties grown at Dumraon manured with 8,200 lbs. of City Sweepings and 6,560 lbs. Castor cake per acre.

	Mungo.	Khari.	Red Bombay.	Poona.	Samshara.	Bhurli.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Cane sugar . .	9·55	11·55	13·70	12·09	13·91	13·01
Glucose . .	1·06	·99	·95	1·16	1·18	·57

NOTE.—Regarding the methods of analysis employed, the cane-sugar was determined in one of Schmidt and Haensch's polariscopes; the glucose was determined by Fehling's volumetric method. Usually two samples of the juice of each plot of cane were analysed and the mean of the two taken.

(*b*) Analyses were made again in 1897 by Dr. Leather of the juice of canes grown on the Dumraon and Burdwan Farms, the results of which are shown in the following table :—

Composition of Juice and Gur of Varieties, Dumraon, 1897.

Variety.	Mungo.		Bhurli.		Samshara.		Red Bombay.		Poona.		Khari.	
Treatment. Manure 250lb nitrogen per acre.	Castor cake.	Cattle dung.	Castor cake.	Cattle dung.	Castor cake.	Cattle dung.	Castor cake.	Cattle dung	Castor cake.	Cattle dung	Castor cake.	Cattle dung.
Cane sugar. . . .	11 73	18·53	13·76	16 09	12·35	15·36	13 31	14 33	12 77	12 35	10·90	15·43
Glucose	1 18	·46	·70	·23	1·34	·72	1·00	85	·81	1·31	·71	·32
Total Sugar .	12·91	13 99	14·46	16 32	13·69	16·08	14 31	15·18	13·58	13 66	11 61	15·75
Ratio: 100 parts of total sugar contain of glucose.	9 14	3 29	4·84	1·40	9·79	4 48	6·99	5·65	5·95	9 59	6·11	2 03

Analyses of the Juice of Varieties grown at the Burdwan Farm.

Variety.	Samshara.	Khari.
Manure applied.	Cattle dung N.=250lb per acre.	Cattle dung N.=250lb per acre.
Cane sugar	14·78	16·59
Glucose	1·33	1·03
Total Sugar .	16·11	17·62

(*c*) Further analyses made of juice in Burdwan by Dr. Leather are shown in the subjoined statement :—

Variety.	Kajli	Shamshara.	Samshara	Khari	Puri
Where grown.	Villages Bunpata, Hartsimal, Kantalgachi	Villages Bunpata, Hartsimal, Kantalgachi.	Experimental Farm.	Experimental Farm	Village
Treatment (manure).	* (Average sample)	* (Average sample)	Castor cake plot Cattle dung plot.	Cattle dung.	..
Juice—					
Specific gravity at 15·5°C.	1,080 : 1,088 : 1,080	1,079 : 1,078 · 1,078 :	1,075 : 1,075 .	1,078	1,083
Cane sugar	17 05	15 24	14 78	16 59	18 02
Glucose	1 54	1 86	1·33	1 03	76
Total Sugar	18 59	17 10	16 11	17 62	18·78
Ratio· 100 parts of total sugar contain of glucose.	8 28	10·88	8·25	5 84	4 04

(*d*) Figures showing the specific gravity of juices of country canes grown at Dumraon, Burdwan and Bihia, at 15·5°C., with calculated per cent. total sugar and per cent. total sugar found are given below. They are the results of analyses made by Dr. Leather in 1897 :—

Samples.		Specific gravity at 15·5°C.	Total sugar calculated from specific gravity.	Total sugar determined	Difference
Varieties at Dumraon Farm.					
Mungo, castor cake	Plot	1,058	14·0	12·9	1·1
Do., cattle dung	,,	1,064	16·0	14 0	2 0
Bhurli, castor cake	,,	1,067	16·5	14·5	2 0
Do, cattle dung	,,	1,074	18	16·3	1·7
Red Banchay, castor cake	,,	1,066	16	14·3	1·7
Do., cattle dung	,,	1,067	16·5	15 2	1·3
Samshara, castor cake	,,	1,067	16 5	13 7	2·8
Do., cattle dung	,,	1,074	18 0	16 1	1·9
Khari, castor cake	,,	1,059	14·5	11·6	2·9
Do., cattle dung	,,	1,073	18 0	15 7	2·3
Poona, castor cake	,,	1,063	15·5	13 6	1·9
Do., cattle dung	,,	1,062	15 0	13 7	1·3
Varieties at Burdwan.					
Kajli (raiyats)		1,081	19·5	18·6	·9
Samshara (raiyats)		1,078	19 0	17·1	1·9
Do. (farm)		1,075	18 0	16·1	1·9
Khari (farm)		1,078	19·0	17 6	1·4
Varieties at Bihia.					
Pensabi (Bihia)		1,071	17 0	15·0	2 0
Mango (Bihia)		1,081	19 5	18·1	1·4

According to the length of time given to the process of boiling, two products may be obtained, *viz.*, *ráb* or *gur*. The latter is a solid mass, and is not very liable to drainage ; the former is liquid, but its crystals are larger than those of *gur* generally. *Chini* is made by draining off the molasses contained in *gur* and *ráb*. In the central districts of Bengal both *gur* and *ráb* are known as *gur*, of which two kinds are met with, one thinner than the other, and thus corresponding to *ráb*.

40. *Sugar-making.*—There are several classes of drained sugar, *viz.*, (1) *dolo* or *kachcha chini*, made directly from *ráb*, as will be described later on, by draining off the uncrystallizable molasses; (2) *pakka chini*, made by refining *ráb* or *gur* by re-boiling it and with the assistance of defœcants, and by draining off the molasses afterwards; (3) *pakka dolo*, an intermediate class of *chini* made in the date-growing districts by refining a mixture of juice and *gur* and subsequently draining off the molasses; (4) *dowārā chini* (litterally *double refined*, so-called from refining *pakka* or *dolo* sugar over again; (5) *doem chini*, which is a second crop of sugar obtained by re-boiling the molasses, which are separated in the manufacture of *kachcha* and *pakka chinis*; it is known as *gonr* or *khanr* in Central Bengal.

Kachcha sugar is made directly from *ráb*, which is a mixture of crystals of sugar and liquid molasses. As the *ráb* is not subjected to any refining process, the quality of the *chini* entirely depends upon that of the *ráb* itself. In Bihar the *ráb* is placed in a *gamla*, or *nād*, or earthen vessel, which is provided with a hole at the bottom. The liquid molasses are allowed to drain naturally through the hole for two or three days. The greater portion of the contained molasses is thus drained off. In Lower Bengal, where sugar refinery is carried on to a limited exent only, the *gur* being sold and consumed mostly in the raw state, the method adopted is very similar and is as follows:—When the *gur* or *ráb* in the earthen pots in which it is kept has become granular and has separated from a portion of the uncrystallizable sugar, it is put in gunny bags, which are pressed laterally by means of bamboo slips tied together. These bags are placed on earthen vessels, and when the greater part of the molasses has thus been got rid of, the *gur* is removed to baskets placed on *gamlas*. In order to carry the separation further, the top of the partially drained *ráb* is loosened with an iron hoe (*khurpi*) to the depth of 3 or 4 inches, and a quantity of an aquatic weed called *sewár* or *ganj* (*Villisneria*) put over it. Two days after a crust of brownish white granular sugar is found to have been formed on the surface. The crust is scraped off with the hoe, and a fresh layer of *sewár* is put on the newly exposed surface. A second layer of sugar is scraped off on the third day following; the *sewár* is repeated, and so on, till the entire mass is worked off. In the native methods of manufacturing sugar of any kind, *kachcha*, *pakka*, *dowārā*, etc., the *sewár* is indispensable. The sugar is not taken off so long as there is any heat felt below the layer of *sewár*. In making *pakka* sugar, a small quantity of castor seed emulsion is added to the syrup immediately it is ladled out of the boiling pan into the cooling vats.

The proportion of *kachcha chini* to *ráb* out of which the *chini* is made varies from 35 to 50 per cent. The *ráb* made in the coldest weather contains, all other conditions remaining the same, the largest proportion of crystallized sugar, and hence yields a high percentage of *chini*; that made in comparatively hot weather, as in *Falgun* and *Chait*, contains the least proportion of crystallized sugar, and hence yields a low percentage of *chini*.

The following shows the profits derived from the manufacture of *kachcha* sugar by the native process:—

One hundred maunds of *ráb* would yield on the average 40 maunds of *kachcha* sugar, 8 maunds of *doem* sugar, and 42 maunds of sour molasses fit only for tobacco and distillation. The outturn would therefore be—

		Rs.
40 maunds *kachcha* sugar, at Rs. 8	. . . . .	320
8 „ *doem* „ „ 6	. . . . .	48
42 „ molasses, at Re. 1	. . . . .	42
	TOTAL . .	410

Kachcha sugar is valued by *halwais* for making different kinds of sweetmeat. It is also consumed in the hot weather in the form of *sharbat*. In the Bengal districts both cane and date *kachcha* sugars are highly valued for making *sandesh*, which is the best kind of bazar sweetmeat made in Bengal.

Pakka sugar can be made both from *gur* and *ráb*. The manufacture of *pakka* sugar includes several stages, which are described in order below:—

A large iron pan, made by local blacksmiths, usually eight feet in diameter, and one foot deep at the centre, is permanently set over a

correspondingly large furnace. The charge of *gur* or *ráb* (ordinarily 25 maunds) is mixed with three or four times its bulk of water, to make the syrup of the same consistency as cane-juice. The clarification of the syrup takes about 6 hours, from 6 o'clock in the morning to 12 o'clock at noon. As the syrup boils in the pan, quantities of much diluted milk are added to it from time to time. The scum collects on the side of the pan and is removed with a perforated ladle (*jhanjhiri*). The solution of milk is added so long as the syrup continues to throw up any scum. The syrup, when fully defœcated, is ladled out and strained through a strong country cloth placed over a basket. The strained syrup is received into earthen *náds* or vats, which are embedded in a raised mud floor built round the furnace.

After the whole of the syrup has been baled out of the boiling pan, the latter is cleaned and rinsed with water. A portion of the clarified syrup (about two maunds at a time) is ladled back into the pan. On coming into contract with the heated surface of the pan, it boils up violently at once, and is continually stirred, in order to prevent burning against the bottom and sides of the pan. The syrup attains its proper consistency in about ten minutes. Immediately before being ladled out into the cooling *náds* or vats, about 4 ounces of castor seed emulsion are added and stirred into the thickening syrup. It is supposed to have the power of inducing the molasses to run off the sugar with greater ease and speed.

As soon as one charge of the syrup is ladled out of the pan, a fresh charge of syrup is placed in it and treated in the same way as above.

The thickened syrup is ladled from the boiling pan into the first of a series of five cooling vats: of these the first, which is closest to the pan and the last which is furthest from it are larger in size than the intermediate ones. The syrup is stirred in the first vat for a minute or two, then ladled into the second vat, where it is stirred for a minute or two, then ladled into the third, and so on, into the fifth or the last one. When a sufficient quantity of syrup has been collected in the last vat, it is taken in pots to the draining house, and poured into deep earthen vessels to solidify and granulate. These vessels are buried in raised mud floors and ranged in parallel rows. They are provided with a hole at the bottom, which is kept plugged with a grass rope. In about a week's time the syrup fully solidifies and granulates; the plug is now taken off, and the molasses which have collected at the bottom of the *nád* are allowed to drain off. When they have ceased to run, the solidified syrup is broken up into large lumps with an iron shovel, and transferred to a second series of *náds*, where the remainder of the contained molasses is drained off by means of *sewár* in the same way as in the manufacture of *kachcha* sugar.

The large lumps of the solidified material are broken by the hand into small pieces, which are now transferred to the second series of draining vats alluded to above. The bottoms of these vats are covered each with a grass mat and provided with a hole for the molasses to pass off. The latter drain to a certain extent for two or three days. When they have ceased to run, the upper layer of the solid matter is grubbed up with a *khurpi* or a hoe to the depth of three or four inches, and a layer of fresh wet *sewár* is placed over the surface. The removal of sugar and replacing of *sewár* are done in the same way as in the manufacture of *kachcha* sugar.

The sugar is removed from the *nád*, as a rule, in the afternoon; on the following morning it is spread out on a large mat to dry in the sun.

The molasses which drain off the solid matter are conveyed by gutters to a pit. They collect here during the season of the manufacture of *pakka* sugar, which extends up to the beginning of the rainy season. During the rainy season the manufacture of *pakka* sugar cannot be conveniently carried on on account of the difficulty of drying it in the sun. The molasses which have collected in the pit are now taken out, re-boiled and treated in the same fashion as *gur* or *ráb* in the manufacture of *pakka* suggar. They may yield from 10 to 16 per cent. of second or *doem* sugar. The molasses drained off from *ráb* as a by-product in the manufacture of *kachcha* sugar are also treated in the same way, and yield a second crop of sugar. One hundred maunds of *gur* or *ráb* yield on an average 40 maunds of *pakka* sugar, 6 to 10 maunds of

doem sugar; the remainder, more or less diluted with water, forms the molasses.

The cost and outturn may be estimated as below :—

	Cost.
	Rs.
100 maunds of *gur*, at Rs. 3-8	350
Cost of labour	50
Cost of fuel	25
Total	425

Outturn.

40 maunds of *pakka* sugar, at Rs. 11	440
8 „ of *doem* „ „ 6	48
52 „ of molasses, at Re. 1	52
Total outturn	540
Net profit	115

= 21 per cent. nearly on the outlay.

Dowārā sugar is made by subjecting *dolo* and *khanr* sugars to a second course of clarification, and boiling the reclarified syrup to a solidified form, and treating the latter with *sewár* in the same way as *pakka* sugar. *Dowārā* sugar is the dearest in Bengal, and its use is limited to the preparation of the best kinds of native sweets.

The Chandpore date sugar is made by an English firm at Chandpore in Jessore out of coarse sugar. Bones are not used for clarification, and the molasses are separated by means of a centrifugal turbine driven by steam power. The sugar turned out at the Chandpore Factory is much superior to native *dolo* or *pakka* sugar; and no bones or other impure matters being used, it is very popular in the district.

Mauritius sugar is the most formidable enemy against which the Bengal sugar has now to contend. The Mauritius sugar, like beet sugar and all other refined foreign sugars, is not adapted to the preparation of *sandesh*, a favourite sweetmeat of Bengal. The reason is that it does not contain a sufficient proportion of molasses which are required to produce adhesiveness between the sugar and the curd in *sandesh*. Nor are the Mauritius and other refined sugars fitted for the above reason for the preparation of *batasha*—a preparation of sugar largely eaten by the people. But for making various other kinds of bazar sweetmeats, Mauritius sugar answers as well as, if not better than, the best kind of native sugar. All foreign white sugars, as well as those from the Cossipore and Taherpore Factories, are known to the people as *kaler-chini* or machine sugar, and are, rightly or wrongly, generally associated in the minds of the people with bone-charcoal, and if it were not for the extreme low price at which Mauritius sugar is sold, it would have been avoided as much as the other kinds of machine sugar.

Beet sugar comes from Europe. It is not in favour with sweetmeat-makers, as it is considered much less sweet to the taste than the native and Mauritius sugars. Chinese sugar probably comes from Java and the Straits Settlements. Madras sugar is used to a small extent by sweetmeat-makers; it is the produce of the Aska and several other refineries in Madras.

According to the Annual Reports of the Indian Factories Act, the number of sugar works with improved machinery during the quinquennial period ending 1904 was as follows :—

Year.	No.
1900	5
1901	5
1902	6
1903	8
1904	5

No statistics of outturn at the above refineries are available.

Besides the above, there are very small native refineries where sugar is manufactured according to indigenous methods. Enquiries made in 1905 showed that, inclusive of the above refineries, there were altogether 124 refineries—European and Native—in 1905, as against 170 refineries in 1899. The decrease in the number of small refineries was chiefly noticeable in the district of Saran and Darbhanga in Bihar. Elsewhere the industry showed little or no change. Statistics of the output of these refineries is not available.

With the failure of indigo, sugar-making is now being taken up on a considerable scale in Bihar, and with good prospects of success. It may be asked, why former attempts at sugar manufacture in Bihar failed if present prospects are encouraging. The answer is given in a report on the cultivation of sugar by Indigo planters in Bihar (published by the Government of India in 1901), and runs as follows: "Conditions were radically different in the days—the last decade of the first-half of the century—when a sudden mania for the growth and manufacture of sugar took possession of the Bihar planters. Much, of the machinery ordered out in haste was found unsuitable, the persons who were to work it did not know their business, there was no means of repairing broken machines, some parts of the machinery were lost in the long and laborious transit up the river which then formed practically the only means of communication, the sugar made was of a class for which, at that time, there was no demand in the country, and all of it was sent down in boats to Calcutta, suffering heavily from wastage by theft and leakage in ill-formed boats, while there was not infrequently complete loss of boat and cargo. When the sugar, or what was left of it, finally reached its destination after a very long journey, during which interest and other charges were accumulating, it could not find a profitable market in competition with sugar produced much nearer the market and more cheaply. Further, just as the industry was started, there occurred the failure in the Union Bank, and the planter found that it was hopeless to obtain funds to any extent."

In the same report, Mr. Ernest Mylne of Bihia in the Shahabad district, who made experiments some years ago, found that the chief difficulties to be contended against were —

(1) Heavy cost of cultivation.
(2) Want of sufficient and suitable land near the sugar works
(3) Want of cheap manure.
(4) Heavy cost of carrying cane to the works.
(5) Uncertain yield per acre owing to variable seasons.
(6) Refusal of the *raiyat* to contract to grow cane for the sugar factory.
(7) Refusal of *raiyats* to sell their standing crop of cane, or sell any portion of it at a fair valuation.

There is no reason why most of these difficulties should not be grappled with.

The statement below gives the results of analyses of semi-refined sugar and of *gur* made from the molasses. The analyses were made by Dr. Leather of samples obtained in Bihia in the year 1896 :—

	Sugar obtained by the hand centrifugal.	*Gur* from the molasses of the same	Sugar obtained by the hand centrifugal.	Sugar purified by wet weed
Cane sugar	89·48	65·71	92·20	96 67
Glucose	3·34	13·81	1·95	·89
	92·82	79 52	94·15	97·56
Ratio: 100 parts of total sugar contain glucose.	3·6	17·3	2·0	·91

It will be seen that the *gur* which was prepared from the molasses was not of very poor quality : indeed, it was nearly as good as some of the *gurs* which were prepared from juice direct at the farms.

Analyses were again made by Dr. Leather with Bihia sugar in 1897. The composition of these sugars, which were manufactured with the hand turbine are given in the table below :—

Composition of the Turbine Sugar made from the Rab.

	Turbine Sugar No. 1.	Turbine Sugar No. 2.	Turbine Sugar No. 3.	Turbine Sugar No. 4.
Cane-sugar	95·10	94·02	95·22	90·81
Glucose	·77	1·04	1·06	1·94
Insoluble mineral matter	·29	·38	·17	·24
Lime	·17	·26	·17	·12
Other soluble mineral matter	·40	·63	·64	·75
Water	·40	·76	·77	2·78
Other impurities	2·87	2·91	1·97	3·86
TOTAL	100 00	100·00	100·00	100·00
Percentage of glucose on total sugar	·8	1·0	1·1	2·1

A brief statement is appended (Appendix IV) illustrating the course of the sugar trade in Bengal, during the last five years. Throughout the statement, Eastern Bengal is included with Bengal Proper, because separate figures are not available The statement shows the imports and exports of sugar by land and sea into and from Bengal, and figures have been added to show the net imports into Bengal, the production in Bengal, and the presumptive consumption in Bengal. It will be seen from that statement that there has been a marked progressive increase in the imports from foreign countries since the year 1901, tending to show that the experiment of countervailing duties has not proved a success. The figures subjoined below also tend to show that the countervailing duties did not exercise any check on the decline in the cultivation of sugarcane. The area under this crop in Bengal fell from 518,500 acres in 1900-01 to 436,400 acres in 1903-04. There has been some extension of the area since, and it remains to be seen whether this revival is going to last :—

Acreage under sugarcane.

Year.	Area in acres.
1900-01	518,500
1901-02	438,500
1902-03	446,100
1903-04	436,400
1904-05	449,400
1905-06	449,100

The legislation of 1899 does not appear to have had much effect upon the competition of bounty-fed beet sugar, which comes chiefly from Germany and Austria-Hungary, as will be seen from the following statement.

The imports reached their highest figures in 1901-02 and in 1905-06 ; and taking averages of the imports during and after the legislation, it will be seen that the level of the average after legislation has been above that of the average before legislation :—

Imports of the sugar from Germany and Austria-Hungary.

Year.	Amount in cwts.
1899-00	196,139
1900-01	507,677
1901-02	853,645
1902-03	214,088
1903-04	58,000
1904-05	355,907
1905-06	885,661

41. In reference to this paragraph, copy of a letter received from the Manager of the Ottur sugarworks in Bihar is appended for information (*vide* Appendix V). This is the only factory from which any definite information has been received.

N. N BANERJEE,
Agricultural Department, Bengal.

APPENDIX I.

Statement showing the normal rainfall of the different districts of Bengal.

Districts.	January.	February.	March	April.	May.	June.	July	August.	September.	October	November.	December.
1	2	3	4	5	6	7	8	9	10	11	12	13
Burdwan	0 41	0 69	1·03	1 88	5 03	10 15	12 25	11 70	8 40	3 35	0 63	0·10
Birbhum	0 42	0 73	0 67	1 15	4 07	10 93	12 49	10 93	10 30	3 52	0 41	0 07
Bankura	0 30	0 45	1 00	1 83	4·35	10 63	12 22	11 88	8 70	3 15	0·64	0 11
Midnapore	0 24	0 53	1·19	1 51	5 30	10 23	13 43	12 52	9 01	4 41	0 64	0 13
Hoogly	0 36	1 15	1·23	2 07	5 50	10 23	12 02	12 51	8 83	3 02	0 50	0 13
Howrah	0 20	0 09	1 02	1·61	5 27	10 93	11 53	11·10	9 45	3 79	0 51	0 13
24-Parganas	0 33	1 16	1·20	1 73	5 43	10·80	12 03	13 20	10·01	5·21	0 82	0 17
Calcutta	0·29	1 02	1·14	1 51	5 60	11·01	13 31	13 80	10·40	3 67	0 02	0 31
Nadia	0 40	1 09	1·43	2 83	6 72	10 00	10 36	10 90	8 13	4 01	0 74	0 11
Murshidabad	0 45	0 76	0 93	1 65	5 13	10 16	10 90	10 45	0 35	3 75	0 49	0 09
Jessore	0 13	1 15	1 81	3 30	7 13	11 60	10 01	10 87	8 43	4 44	0 83	14
Khulna	0 34	1 07	1 49	3 61	6 45	12·77	13 10	13 52	0 55	6 21	0·93	0 15
Patna	0·77	0 02	0·35	0 23	1 75	7 71	12 40	11 21	7 20	2 03	0 19	0 10
Gaya	0 70	0 01	0 42	0 17	1·18	6 53	12 40	11·72	0 75	2 27	0·20	0 22
Shahabad	0 78	0 73	0·26	0 17	0 77	6 44	12 69	11·66	0·96	2 61	0 35	0·24
Saran	0 72	0 44	0 10	0 30	1·55	7 05	11 77	11·00	8 20	2 07	0·18	0 10
Champaran	0 72	0 43	0 44	0 60	2 61	0 36	13 72	12 61	0 89	3 23	0 11	0 15
Muzaffarpur . . .	0 77	0 47	0 35	0 55	2 23	7 41	12 03	11 00	5 17	3 01	0 11	0 09
Darbhanga . . .	0 74	0 42	0 33	0 68	2 50	7 17	12 29	12 49	10·06	2 16	0 11	0 07
Monghyr . . .	0 77	0 63	0 35	0 53	2 16	7 03	13 30	11 41	9 57	2·40	0 09	0 07
Bhagalpur . . .	0·66	0 51	0 44	0 00	3 15	8 3	12 72	11 68	10 19	2 53	0 07	0·07
Darjeeling . . .	0 83	0 80	1 70	4·21	9 20	23 33	32 08	21 80	18 22	4 23	0 31	0 22
Purnea	0 46	0 41	0 49	1 57	5 41	12 01	15 16	14 09	15 44	2 56	0 07	.0 05
Sonthal Parganas . .	0 02	0 00	0 43	0 82	2 75	9 79	12 05	11·60	11 10	3 13	0 28	0 03
Sambalpur . .	0 13	0 11	0 03	0 43	1 23	10·40	14 37	15 18	6 31	1 03	0 43	0 25
Angul . .	0 23	0 51	0 00	1 33	2 11	0 78	11 17	.0 45	0 57	4 83	1 09	0·30
Cuttack . .	0 30	0 74	1·17	1 27	4 23	0 71	11 89	12 77	10 10	6 19	1 07	0 29
Balasore	0 85	1 04	1 40	1 79	5·00	9 10	12 03	11·35	11·13	5·54	1·21	0 19
Puri	0 22	0 75	0 90	0 59	3 13	6 17	10 23	12 05	0 83	7 18	2 30	0 34
Hazaribagh	0 71	0 82	0 70	0 30	1 80	8 43	14·38	12 60	8·37	3 13	0 31	0 22
Ranchi	0 15	0 82	0 60	1 07	1 60	0 64	14 38	13 31	8·30	2 03	0 38	0 20
Palamau	0 62	0 63	0 51	0 23	0 04	0 60	13 65	13 42	7 05	2 00	0 20	0 35
Manbhum	0 47	0·74	0 83	1 02	2 81	0 50	13 80	12 78	8 52	2 70	0 31	0 12
Singhbhum . . .	0 24	0·77	0 70	1 45	3 33	10·67	15 07	14 54	8 10	2 60	0 42	0 18

APPENDIX II.

Normal mean temperature of Districts in Bengal.

Districts.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1	2	3	4	5	6	7	8	9	10	11	12	13
Burdwan	66·0	71·2	81·1	88·2	89·2	86·5	84·8	84·2	84·3	81·7	73·7	67·1
Raniganj	66·2	69·3	80·3	88·8	88·1	87·4	84·2	83·6	83·3	80·8	72·3	66·1
Bankura	66·9	70·1	78·6	86·0	86·6	87·2	83·0	83·2	83·1	80·8	73·0	66·2
Midnapore	66·2	72·1	80·3	86·2	88·6	87·0	84·0	83·2	83·2	80·6	73·1	67·2
24-Parganas	67·0	73·4	81·2	85·4	86·6	83·1	84·2	83·5	83·9	81·0	74·4	67·7
Calcutta	66·2	71·3	80·2	85·7	86·0	84·8	83·8	83·7	83·8	80·6	73·0	66·3
Nadia	64·8	67·8	78·8	86·6	86·6	85·8	83·0	83·5	83·1	80·7	72·8	66·4
Murshidabad	65·2	69·3	79·3	87·4	89·6	85·4	84·1	83·0	83·7	80·9	73·0	66·9
Jessore	65·5	70·3	81·4	86·2	85·8	85·2	84·2	83·7	84·0	82·6	73·6	66·3
Patna	61·6	65·9	76·5	87·1	89·0	89·2	85·0	84·3	84·0	80·4	71·1	63·0
Gaya	63·8	66·8	79·8	89·2	92·2	89·0	85·1	84·2	84·1	80·3	71·5	63·0
Shahabad — Dehri	64·0	68·1	77·8	86·2	92·1	90·3	84·4	83·2	83·1	79·0	71·5	64·6
Shahabad — Buxar	63·0	65·2	77·2	86·0	91·9	88·7	84·1	83·5	83·3	79·6	70·6	62·8
Shahabad — Arrah	61·5	64·5	77·1	86·0	89·5	88·7	84·8	84·2	83·8	79·5	70·4	62·3
Saran	61·0	64·7	76·1	85·8	88·6	87·7	85·0	84·0	83·0	79·6	70·1	63·0
Champaran	60·6	62·2	73·4	82·0	85·3	85·3	84·3	83·7	83·1	78·3	69·8	61·2
Muzaffarpur	Normal not yet worked out.											
Darbhanga	62·5	65·7	78·4	84·0	86·0	85·8	84·7	84·0	83·6	79·0	71·7	64·2
Bhagalpur	62·3	65·1	77·0	84·9	86·1	85·5	84·2	83·6	83·1	79·4	70·8	62·0
Darjeeling	40·8	41·8	49·5	55·6	58·2	60·7	61·8	61·4	59·8	55·3	48·3	42·8
Purnea	61·6	65·3	76·2	83·5	84·6	84·7	84·6	83·8	82·4	79·8	70·8	62·8
Santhal Parganas	63·6	67·0	78·6	87·2	87·8	86·1	84·1	82·4	82·3	79·0	70·4	63·5
Sambalpur	...	...	...	...	...	...	...	...	...	...	73·1	65·0
Cuttack — Cuttack	72·3	77·0	84·7	90·1	90·9	87·9	84·2	83·7	84·3	82·3	75·6	70·4
Cuttack — False Point	68·7	73·8	79·6	83·8	85·4	85·2	83·3	82·0	83·0	80·3	74·0	67·7
Cuttack — Balasore	68·0	73·7	81·2	86·7	88·3	86·8	83·5	82·9	83·1	80·5	73·3	67·5
Puri	Normal not yet worked out.											
Hazaribagh	62·0	66·3	76·3	85·4	87·1	84·2	79·2	78·6	78·4	75·1	67·6	61·4
Ranchi	62·7	66·6	75·5	84·6	87·8	82·9	75·5	76·0	78·1	74·2	67·7	62·5
Palamau	Normal not yet worked out.											
Manbhum												
Singhbhum	67·6	71·8	80·0	89·8	92·6	87·5	83·7	82·8	83·1	79·5	71·0	63·1

APPENDIX III.

Statement showing the composition and ordinary prices of oil-cakes used as manure for sugarcane.

(1) Castor-cake, price R2 per maund—	
Moisture	11·01
* Organic matter	75·49
† Soluble mineral matter	8 27
Sand	5·23
	100 00
* Nitrogen	6 48
† Phosphoric acid	3 05
Potash	1·48
(2) Rape-cake, price R2 per maund—	
Moisture	12·56
* Organic matter	70·86
† Soluble mineral matter	9·01
Sand	7·57
	100·00
* Nitrogen	6 14
† Phosphoric acid	3·00
Potash	1·45
(3) Safflower-cake, price R2 per maund—	
Moisture	8·36
* Organic matter	83 74
† Soluble mineral matter	6·21
Sodium Cloride	1·69
	100 00
* Nitrogen	7·61
† Phosphoric acid	3·54
Potash	1·40
(4) Neem-cake, price R2-4 per maund—	
Moisture	5 66
* Organic matter	84·56
† Potassium nitrate	7·55
Potassium chloride	2·23
	100 00
* Nitrogen	6·61
† Phosphoric acid	1·90
Potash	2·89

	Price per maund
	R a.
(5) Linseed-cake	2 8
(6) Poppy-cake	3 0
(7) Sesamum-cake	3 0
(8) Mahua-cake	2 8

APPENDIX IV.

Statement showing the course of the trade in Sugar in Bengal during the five years 1901-02 to 1905-06.

	1901 01.	1902 03	1903 04	1904 05	1905 06	Remarks.
Imports.	Cwts	Cwts.	Cwts	Cwts.	Cwts.	
Refined sugar—						
From Foreign countries by sea* and land.	1,515,957	1,510 110	1,670,005	2,107 403	2,211,349	* Imports into Bengal by sea up to September 1905 included a certain amount of low grade sugar as refined, which has been classed as unrefined from October 1905.
„ Indian ports and provinces . .	424 112	302 600	309,334	414 428	281,949	
Total refined sugar .	1,950,069	1 874,023	2,217 459	2 521,891	2,493,297	
Unrefined sugar and molasses—						
Unrefined sugar—						
From Foreign countries by sea and land.	..	..	...	..	220,469	
„ Indian ports and provinces . .	74,607	43,340	03,402	46,011	61,617	
Molasses†—						† Molasses=*rab*, *gur*, jaggery, *shiro* and treacle
From Foreign countries	416,918	417,200	257 677	333 851	533 071	Molasses is not distinguished from other kinds of unrefined sugar when imported coastwise or from foreign countries by land. But the quantity in these cases is trifling.
„ Indian provinces	590,334	531,262	284,205	577,021	583,021	
Total unrefined sugar and molasses .	1,080,859	1,024 808	555 344	970,310	1,407,079	
Total imports from foreign countries .	1 931,875	1,063,415	2,184,002	2,441,013	2,978 877	
„ „ Indian provinces .	3,105,0 3	910, 109	900,421	1,040,033	836,490	
Grand Total imports of sugar .	3,030,0.8	2,003,523	3,100,823	3,491,107	3,870,387	
Exports						
Refined sugar—						
To Foreign countries by sea and land .	13 701	14 275	15,613	20,137	17,033	
„ Indian ports and provinces . .	154,8 0	154 032	276,245	439,4 8	417,101	
Total refined sugar .	167 420	169,000	293,783	459,605	435,194	
Unrefined sugar and molasses—						
Unrefined sugar—						
To Foreign countries by sea and land .	61 110	40,751	42,575	43 957	53 018	
„ Indian ports and provinces . .	170,735	201,360	302 511	393,6.0	443,793	
Molasses—						
To Indian provinces (by rail and river only)	693,016	732,811	6'8,807	662,688	631,638	
Total unrefined sugar and molasses .	1,218 495	1 0 4,923	1,004 283	1,059 519	1,134,316	
Total exports to foreign countries .	01,707	84 120	58 088	03,494	71 041	
Total exports to Indian ports and provinc s	13,220,,09	1,178,302	1,820,953	1,487 051	1,197,259	
Grand Total exports of sugar .	1,,95,01E	1,283 123	1,035,011	1 549,139	1,560,300	
Net Imports of sugar	1,851 013	1 070,493	1 715 782	1,0 2 9'0	2,300,547	
Production of sugar	13 628,200	13,031,000	13 078,000	12,60 000	12,300,000	
Presumptive consumption	15,179,213	15,302,005	14,793,782	14,620,010	14,600,547	

APPENDIX V.

Dated Ottur, the 28th December 1906.

From—H. M. Carey, Esq., Manager, Ottur Sugar Works, Silout Tirhut State Ry.,

To—The Director of Agriculture, Bengal.

I regret not having found time before to reply to your letter of the 5th ultimo No. 4623.

Prices ruling at present in Bihar for cane are Re. 0-1-6 and Re. 0-5 0 per maund which should always be a safe price for the manufacturer and gives the grower a good return. Seeing the great fluctuations in the price of sugar, these are high prices for a minimum rate, but when sugar exceeds a certain price, the grower should be allowed to participate in the high prices.

The *raiyat* has no statistics to know what pays him best, but I am sure, he would find the above rates for his cane would pay much better than making jaggery in the primitive and wasteful manner prevailing. It is a surprising fact, but the price of *gur* in this country seems to be in no way ruled by the world's price of sugar, but with the latter at its lowest and *gur* at its highest, I still think it would pay the *raiyat* to sell his canes.

Round these parts, eight small central factories have been erected in the last few years. Of these three are new and commence work this season; one is closed down as sufficient supplies of cane in the neighbourhood are unprocurable. With one exception, the others have all suffered up to date on the same account. Two small factories were erected for making jaggery of sorts, but were promptly closed as wasteful and unsatisfactory. A third since erected on the same lines seems to have done poorly so far. It is not likely in these parts, where so much tobacco is grown, it will ever be necessary or pay to make spirits. There is a good demand for molasses at prices that pay better than spirit-making would.

The size of the factory and the capital necessary entirely depends on the available cane lands within a practical distance. It appears to me, that in Bihar small central factories are most suitable as the cane plots are generally so scattered and small in size that light railways would hardly serve and with bullock cart transport only a factory to deal with 300 tons of cane a day would probably be quite large enough as, with 100 days' working, the total of 20,000 tons of cane required would represent the most that would be grown year in and year out within an area that could be suitably served by bullock carts. If 10,000 tons is more likely to be the figure, then let a factory for 100 tons per *diem* be selected.

Roughly speaking, a sum of ₹1,50,000 should cover the total cost of erection of a complete factory of the last-mentioned class, but I have not the time and sufficient data at my disposal to give a "carefully compiled statement."

Double crushing with or without shredding rolls preceding each mill of 3 rolls is the general type of crushing plant used in the factories here. Heaters, clarifiers, subsiding tanks, filters, and filter presses, are also general in varying forms. Triple effect evaporation, vacuum pan, centrifugals, dryers, and crushers, with large tank room for low grades and molasses roughly complete the outfit of the various factories here.

The capacity of the mills varies from 100-100 tons cane per *diem* and should work 3 to 4 months at least for a full crop, but so far few have had a sufficiently liberal supply of cane. All the above-mentioned factories deal with cane, some continuing work after the cane season refining native sugars. I have heard of no one so far importing foreign sugars for refining purposes. One factory alone not included in the above-mentioned deals with jaggery only for its raw material.

The general machinery in use is not suited to any other industrial purposes than sugar refining.

Small factories had much better make a raw refining sugar to feed a big refinery. The cost of manufacture is much reduced and expensive, skilled supervision almost dispensed with, the latter being concentrated in the refinery though advising and checking results of the small raw sugar factories. One sales department and a limited number and regular grades of sugar also tends to economy. Small factories making only raw sugar could be run entirely by natives, visited by experts from time to time to check waste.

Madras.

Proceedings of the Board of Revenue (Revenue Settlement, Survey, Land Records and Agriculture), dated the 21st January 1907. 372-Misc.

The Hon'ble Mr. A. E. Castlestuart Stuart, I.C.S., Commissioner of Revenue Settlement, Survey, Land Records and Agriculture.

Read the following letter from the Director of Agriculture, No. 39—Dis., dated the 16th January 1907.

With reference to paragraph 3 of B. P. No. * 236 Misc., of the 11th instant, calling on the Government Botanist to submit the result of the enquiry into the sugarcane industry in this Presidency, I have the honour to inform you that the Government Botanist, who is just proceeding on leave on medical certificate, informs me that he has not prepared any report. The Agricultural Inspector deputed by the Government Botanist to make enquiries on the subject in various districts has not yet completed them. It will not therefore be practicable to send in any report on sugarcane-growing in this Presidency in time for the next meeting at Cawnpore.

*Not printed.

Resolution.

Communicated to the Inspector-General of Agriculture, in continuation of the correspondence ending with B. P. No.† 324-Misc., dated the 18th January 1907.

†Not printed.

(True extract.)

L. W. SWAMIKANNU,
Secretary.

Punjab.

Introductory.

1. Owing to the very limited acquaintance of the writer with the cultivation of sugarcane and manufacture of its products, this note does not aim at any exhaustive treatment of the subject, but is intended merely to give a general idea of the status of the sugarcane industry in the Province. Some day, and it is to be hoped at no distant date, the subject will be fully dealt with. The note follows Mr. Barber's suggested form of inquiry and forms indeed as far as possible replies to his queries, and it is hoped may be of some use to him. It is to be regretted that little has been done in the way of experimental work with regard to the crop, the only Experimental Station in the Province being at present situated at some distance from the cane-growing tracts. This, however, will be soon rectified by the establishment of a second station at Jullunder in the heart of the cane-growing districts.

The writer has omitted any attempt to describe or classify the varieties of sugarcanes and to make any definite suggestions as to lines on which improvements may be made. His acquaintance with the crop has been too limited for that.

It is, however, an undisputed fact that the valuable crops, such as sugarcane, form the backbone of the agriculture of the country. The growing of such crops can only be accomplished by much labour and good husbandry. The former factor admits of the land supporting a greater number of people; the latter tends to the upholding of the fertility of the soil.

An extension of the area under the crop means an extension of the land under good cultivation But it also means more; for the subject includes both the cultivation of the crop and the industry of the manufacture of its products.

Climate.

2. Table I gives the average rainfall and its distribution throughout the year for the Punjab. The figures for the hill stations, which can easily be recognised, are retained.

A glance at the table at once shows the scant rainfall during the winter and spring months and the late arrival of the monsoon, also the small annual rainfall in the western, southern and south-western parts of the Province. The principal falls occur on the submontane tracts which will be found further on to correspond to the chief sugarcane districts The climate of the Province may be briefly described as hot and very dry—intensely hot by day and night from May to August in the tracts which receive more or less of the monsoon. the heat continuing up to the end of September where the annual rainfall is low. The daily maximum temperatures generally run from 105° to 110° and above in all the stations in the plains before the rains. The winter months are cool with low temperatures at night and occasional frost From the agricultural point of view the climate is a severe one and tests the hardihood and vitality of plants to the uttermost.

The eastern part of the Province has a more moderate climate than the western, having a shorter hot weather and a milder cold weather.

History of the crops in the Punjab

3. As far as I am able to say, there are no historical references of any antiquity on the subject in this Province. The crop seems to have been in cultivation in the time of Alexander the Great. There is a legend that it was brought into the Punjab by "a great King who brought three things from the sea which required too much water—rice, sugarcane and the buffalo"

There seems to be some evidence that sugarcane cultivation spread originally from the United Provinces to the Punjab. It is quite certain that many of the Punjab varieties have been brought from Meerut and Rohilkhand. The *paunda* varieties are supposed to have come originally from Saharanpur, where they came to from Ceylon. It is believed by some cultivators that the *chan* variety has descended from the wild grass cane (*kahi*) which is occasionally to be met with in the jungle. Whether indigenous or exotic, there exists no information to indicate even roughly at what period cultivation of the plant arose.

The new canal colonies present a field for the study of the crop under new conditions, and a comparison of the figures from 1896 to 1904 gives some indica-

tion of the gradual increase of area during colonization where the colonists brought their own seed and methods of cultivation. A special study of the behaviour of the various varieties under the new conditions of soil and climate, which differ considerably from those of the eastern part of the Province, has not been made, but would be no doubt useful. Special modifications of the cultivation and treatment of the crop will in time probably arise, and its whole history will be interesting to follow.

Extent of the cultivation of sugarcane in the Punjab.

4. Table II gives the acreage under sugarcane in each district of the Province from 1896 to 1905 inclusive, the figures for 1906 not being at present available.

The most striking features is the great decrease in area for the year 1905. This was probably entirely due to the fact that most of the canes set aside for seed were destroyed by frost. The average area for the five years 1896 to 1900 was roughly 346,900 and for the four years 1901 to 1904 (leaving out 1905 as abnormal) 334,900, which shows a decrease of 3¼ per cent in spite of an increase of nearly 20,000 acres in Lyallpur District. The percentage of decrease is perhaps too small to admit of any definite explanation. There are, however, influences which doubtless have some effect on the crop area. Perhaps the chief are the increasing popularity of wheat and cotton in the Province.

A counteracting tendency may be found in the high prices of *gur* and *shakar*. Perhaps a fair estimate of the figures in Table I would be that there is a slight tendency to decrease of area in the older districts and a possibility of expansion in the colonies.

The character of the cultivation of the Province.

5. Broadly speaking, although sugarcane is cultivated in every district, it does not assume any relative importance except in those districts which have a fairly plentiful and secure supply of water in some form or other. The reason of course is obvious: the crop requires a great deal of water for its successful growth and this supply must be fairly secure as the capital outlay is great and failure cannot be lightly risked.

The chief cane-growing districts are, as we might expect,—

(1) Those which have a plentiful supply of irrigation water from canal or wells.
(2) Those having a moderate supply but a relatively higher rainfall.
(3) Those which have a sufficient rainfall for the full growth of the crop. This class of cultivation is in the Punjab confined to those lands which lie close to the hills.

Relatively speaking, the first-mentioned class of land is the most important for sugarcane, security in this case being much greater. Representative tracts are the northern part of Jullunder Division and part of Lahore Division.

The second class of land is represented mainly by the Delhi Division in its southern districts. The third class or *barani* cultivation is mainly carried on and successfully too in the Gurdaspur and Hoshiarpur Districts. Table III has been compiled to shew the relative importance of the crop in each district which is indicated by the percentage of sugarcane to the total area cropped.

The figures used are the total average cultivated areas for the last five years and the average sugarcane area for 1901 to 1904, the year 1905, as before being eliminated.

The more important sugarcane districts may be broadly stated to be those lying in the submontane tract between the Chenab and Jumna rivers. Generally speaking, the crop forms part of the regular rotation. In those parts where it does not assume any relative importance it is to be found in isolated patches round about wells on land which is intensively cultivated.

There are of course other factors which influence the extent and character of the cultivation. Labour must be plentiful and cheap, the land must be of good quality, and manure must be available. The quality of land is perhaps not so much a determinating factor as it might appear, as good land is to be found all over the Province. The scarcity of labour and supply of manure is no doubt one of the reasons why the sugarcane crop is relatively not of so much importance in the canal colonies where land is good and irrigation water cheap.

6. It is impossible for the writer to attempt any classification of the Punjab varieties at present until he has a collection of fully developed specimens beside him. For the same reason nothing but a very general description can be given. As far as possible, a complete collection of the varieties will be submitted at the next meeting of the Board of Agriculture at Cawnpore.

Varieties.

The following is as complete a list as can be given at present. Some of the varieties mentioned are rare and found only as admixtures amongst others. Many of the varieties mentioned appear to be exactly similar and will probably turn out to be the same variety under a different name.

A.—Chewing canes—

These are generally known under the name of "*paunda*" and are thick and succulent.

1. *Paunda.*—Greenish, soft, hard and juicy; the thickest of all varieties.
2. *Pauni or Poni.*—Soft skin—thinner than *paunda*—lighter green colour—corresponds with "*mairti*" of Saharanpur (?)
3. *Kinara.*—White, soft, juicy. This cane is also used for *gur*-making but is not at all common.
4. *Saharni.*—A *paunda* variety which has been imported from Saharanpur.

B.—Gur-making canes—

5. *Chan.*—The most important and most extensively cultivated in the Province, red in colour, thin to medium thickness, skin softish to hard, largish joints, yields small quantity of juice but good percentage of sugar.
6. *Dhaulu or Dholu.*—This is a good variety—whitish resembling *pauni*—smooth soft skin—thicker than *chan* but thinner than *pauni*.
7. *Ekar.*—Resembles *dhaulu*, somewhat thicker when ripe, said to have black lines.
8. Hissar reports give the name *Ganna* to some variety. This however is a general name for medium varieties.
9. *Dohh.*— } *Ikh*, also reported from Hissar. *Ikh* seems to be a
10. *Lat.* — } general name for thin varieties.
11. *Tereru.*—Resembles *dhaulu*, but has a hard, coarse rind.
12. *Kahu.*—A thickish greenish white variety with a soft skin—is said to be a good ratooner.
13. *Kahta.*—A very thin reddish variety—very narrow leaves, hard rind—juice of good quality.
14. *Mendhin.*—Said to be American and found at Sialkot.
15. *Desi of Shahpur.*—Probably *chan*.
16. *Desi of Rohtak.*—Also probably *chan*.
17. *Sortha.*—A soft rinded variety whitish in colour.
18. *Lalri of Karnal.*—Description like *chan*, probably the same variety.
19. *Chinki.*—A poor thin fodder cane (found at Gujrat).
20. *Ghorru.*—A poor, dry, hard cane, found in Ludhiana District; when growing looks well but a poor yielder, tall, suitable for dry sandy tracts.

7. Generally speaking, the soils of the Province are alluvial in origin and a section reveals successive layers of sand, clay and loam. As a rule the land is fertile where the clay or loam outcrops, or where, when the surface is sandy, the clay or loam is not too far down to prevent the roots of plants from reaching it. A seemingly sandy soil may be seen producing excellent crops, but the reason is that the clay is near the surface. In sandy soils where the clay is too far removed from the surface the land is either barren or inferior. The clay is, as a rule, fairly pervious to water and drains readily.

Sugarcane soils.

In general character the typical sugarcane-soil may be said to be an alluvial loam, naturally deficient in organic matter but fairly well supplied with mineral substances.

A shallow layer of sand overlying a stratum of clay is advantageous, the land being easily worked, any caking after irrigation being easily broken up and the moisture conserved

Recorded introduction of new varieties

8. As stated above, it is almost certain that most, if not all, of the Punjab varieties of sugarcane are exotic. Definite and recorded introductions of new varieties, however, are difficult to trace.

The *paunda* variety is said to have come from Shaharanpur and at the time of its introduction was said to have been "as tall as a bamboo and as thick as a man's thigh. At that time it was said to have been very hard." It certainly must have degenerated sadly since those days. Whether any further decline is going on at present, it would be difficult to say.

The only recorded introductions of exotics as an experiment were at the Agri-Horticultural Gardens at Lahore and the Lyallpur Agricultural Station. At the former place a number of new varieties were planted, but the result was a failure, while at the Lyallpur station two Poona varieties, *Bansi* and *Sanabeli*, were grown but produced only 1,914 lbs. of *gur* each per acre against 5,008 lbs. per acre of the local *katha* variety. Neither of the two experiments were persisted in.

There is little doubt but that exotics from more humid climates undergo deterioration in the Punjab. The plant which seems to thrive best in this Province is a thin hardy variety which requires less water and manure than the more succulent varieties, and under present conditions it is questionable if any other type of cane would be popular with the cultivator, who complains that even his own species of cane requires too much water and manure.

Sports and seedlings

9. The appearance of any new variety by sports or otherwise is unknown to the cultivators. Whether such have arisen it is impossible at present to state as there is no record of any scientific observation on the point.

No cases of any canes having been raised from seed are on record although unsuccessful attempts have been made by local officers to do so. The cultivator on the other hand is always on his guard against his canes producing seed.

Other sources of sugar.

10. As far as I am aware, sugar and spirit are produced only from sugarcane in the Province. The following experiment with the object of obtaining *gur* from *juar* was conducted at the Lyallpur Agricultural Station in the years 1901-02 and 1902-03 :—

Variety.	Years	Outturn Per Acre.					Percentages of		
		Green tops and leaves	Stalks.	Juice	Gur.	Grain.	Juice to stalks	*Gur* to Juice	*Gur* to stalks.
Sweet . . .	1901-02	5,024	13,968	6,816	816	..	48 79	11 97	5 84
Local . . .	1902-03	7,896	6,072	3,572	584	644	58 82	16·76	9 28
Sweet . . .	1902 03	4,164	4,140	1,836	276	592	44·84	15·03	6 66
Quetta . . .	...	..	...	...	...	...		...	...

The Annual Report says :— "This year the *gur* was made when the crop was fully matured and this accounts for the higher percentage of *gur* to juice and stalk and of juice to stalk. The *gur* made was of very bad quality like a thick mass of black syrup. The *gur* made last year presented the same characteristics. This syrup sometimes turns into a black hard brittle and solid mass, but it produces no crystals. There appears to be an unduly large proportion of glucose. The results are not encouraging and the experiment will be discontinued.

Planting and reaping seasons

11. The time of planting and reaping vary very little throughout the Province Sowing is usually done from the 25th of February to the end of March.

The first cuttings as a rule being about nine months after sowing time (that is from the end of November to the end of December). It is recognised by cultivators that the best time for cutting is about the new year, but the work has to be begun earlier in order to get the whole area cut in time before the planting of the next crop. Cutting goes on into February, occupying usually about two months.

Rotations

12. Probably in no other respect do the practices of the province vary more than in rotations. It is quite universally understood that sugarcane must not follow sugarcane in the rotation, and hence the practice is rarely met with except on those lands which are renovated annually by silt deposits.

The chief crops in the alternative are wheat, cotton and maize. As a rule sugarcane is preceded by a *rabi* crop, but it is not uncommon to find it grown after a *kharif* crop. Where this practice prevails the usual crop is cotton followed by a catch crop of *sengi*, which is immediately grazed off and the land ploughed up.

Where the preceding crop is a *rabi* crop, it is usually wheat, but as a rule cotton forms part of the rotation at some time or other.

After sugarcane it is usual to follow on with a *kharif* crop, which may be maize,, cotton, etc.

There seems to be no hard and fast rule in any district with regard to rotations, but the above principles are generally adhered to.

The ploughing in of *san* (hemp) and grazing of *sengi* are really manurial practices and will be further noted under that heading, but it may be here mentioned that such practices are chiefly confined to the Jullundar District, where the manurial value of leguminous crops is well understood and the knowledge acted upon.

Catch crops with cane seem to be rarely attempted, but melons are sometimes grown along with the *paunda* varieties.

Protective crops.

13. The usual protective crop for sugarcane where such are grown is *san* hemp. This practice is also most common in the Jullundur District.

Ratooning.

14. Ratooning is not at all common, and, as a rule, finds little favour amongst cultivators. It is carried on mostly in the Gurdaspur and Hoshiarpur Districts, on the land which receives an annual deposit of silt. The usual practice is to plough the land a few times to loosen the earth about the roots. Little or no manure is supplied for the ratoon crop. The after cultivation is the same as for ordinary set planted cane.

Sometimes it may be necessary to have recourse to ratooning owing to scarcity of seed, but generally speaking, ratooning is not common.

The *kahu* cane of Gurdaspur is said to be specially suitable for ratooning.

Cultivation.

15. Cultivation may be broadly classified into three types:—

(1) Where the sugarcane crop follows a *rabi* crop allowing a year's fallow.

(2) Where it follows a *kharif* crop (*e. g.*, maize).

(3) Where it immediately follows a *rabi* catch crop.

The procedure in (1) is described below; in (2) it is identical except that there are fewer ploughings. (3) This is usually brought about by *sengi* being sown amongst the cotton crop. When the latter is cut down the *sengi* is grazed off by cattle and the land ploughed in February. In this case (usually in Jullundur District) little or no manure is given.

Preparatory Tillage

16. Where the crop is preceded by a *rabi* crop ploughing begins as a rule after the wheat harvest, *i. e.*, in June and goes on up to sowing time. As many ploughings as possible are given. In some districts it is said that the land is ploughed about 40, 60 or even 100 times. The general rule seems to be to plough as often as possible and probably the average will be about 15. The fallow then is complete in one sense, that the land is frequently stirred. It is questionable, however, if the ploughings are deep enough, and whether it would not be better economy to give one or two very deep ploughings, reducing the

number. The usual depth of ploughing is not above from 6 to 7 inches and it would be well worth experimenting with deeper stirrings of the soil. Weeding and hoeing are, as a rule, carefully carried out and persisted in until the crop has fairly prevented further operations. The usual amount considered quite necessary is 4 times, but it is done as often as possible. The only implements necessary for the preparation of the soil are the plough and the *sohaga* or leveller.

Planting

17. There is practically only one method of planting, *viz.*, behind the plough. The procedure is as follows. The ploughman proceeds in the usual way and the planters, 6 or 7 for each plough, follow up and lay the cut sets in the furrow pressing them down with their feet as they proceed. The plough comes round again at a distance of about 8 inches making a new furrow and covering the sets in the preceding one. The sets are usually covered with about 3—4 inches of earth. The field is then levelled with the *sohaga* which finishes the operation.

Change of seed.

18. As a rule the cultivator in the Punjab does not bring his sets from a distance, although in some parts of the Delhi Division it is recognised as good practice to bring seed from Meerut. There is no dependable information with regard to the effect of this practice on the growth of the plant and the richness of the juice.

The usual practice is for each cultivator to grow and select his own sets and where these may prove insufficient to purchase new sets locally.

Generally speaking, with the exception of the case mentioned above, the cultivator is averse to using seed brought from a distance, his usual answer being that the outturn is less and the juice poorer, but it is possible that this belief is due to prejudice.

19. The seed canes, except in the case of the *paunda* and soft skinned varieties, are often allowed to stand over till the last, and cut just before sowing. This practice, however, proved disastrous in the winter of 1904 when the standing canes were destroyed by frost, and is likely to go out of fashion

20 The whole cane as a rule is used for cutting into sets except the "tops" and rooting joints. The Punjab canes, especially the *dholu* and *chan* varieties, which form the bulk of the crop, appear to be quite suitable for this practice. The sets get no special treatment in the way of pickling, etc.

The thick or hard-rinded varieties are usually buried for some time before planting, if they have not been stored in pits, to hasten germination. Care is taken to shelter the sets from the sun before planting by covering them up.

The number of joints in a set, varies from two to four. Two, I think, is the more common number.

Number of sets per acre.

21. The number of sets per acre is not usually calculated. An acre of cane is supposed to require from 5,000 to 6,000 whole canes and as from 5 to 6 sets per cane are the usual numbers. 25,000 to 36,000 may be said to be the usual number per acre, although I believe the latter figure is often exceeded. The mode of planting has been mentioned above.

Distance between sets

22. The sets are usually planted from 8—12 inches apart in the furrows which are about 8 inches distant from each other. Owing to irregularity of ploughing the sets are not all planted at an equal depth, but after levelling the usual amount of covering they have is from 3—4 inches.

Vacancies

23. It is not the custom in the Punjab to fill up blanks in the crop, and on the whole considering the large amount of sets planted it is seldom necessary to do so.

Transplanting

24. Transplanting from seed beds seems also to be unknown, but might be very useful as the cane often suffers in its early stages from drought and the ravages of white-ants

Stool planting

25. Stool planting is of very rare occurrence in the Province, but was attempted in some places last year along with ratooning owing to the scarcity of

sets. The effect is reported to have been similar to ratooning, and cultivator say they would not attempt it except under similar circumstances.

Irrigation

26. The two main sources of irrigation water are by wells and canals. Tank irrigation is of limited extent and unimportant in the Province. The canals give on the whole a good and regular supply of water. Well irrigation is effected by means of the Persian wheel and bucket systems. From the point of view of sugarcane cultivation, well water is most scarce during the early days of the crop, but as most of the *kharif* crops require little water before the rains, the sugarcane crop gets the greater bulk of the water and on the whole this is sufficient. After the rains break the critical time is past and water is more abundant in the wells. No doubt a more plentiful and cheaper supply of irrigation water in the cane districts would lead to an increase of area under the crop. Everywhere one is met by the cry that "sugarcane requires too much water." In some tracts unfortunately the water level is sinking and this is bound to affect, if it is not now already affecting, the area under sugarcane. The crop is bound to be the first to be affected through diminution of the water supply. The supplanting of the sugarcane crop by others in some districts has probably as its ultimate cause the increasing scarcity of water. The use of oil engine pumps might possibly lead to an increase of area under the crop, but until definite experiments have been carried out to determine their economic value in the Province as compared with present methods of water-lifting, no opinion can be expressed. It will be interesting to observe the results of the canal irrigation extension schemes at present being carried out on the sugarcane area in the Province. "Cheap water and plenty of it" is the main stay of the crop.

Drainage

27. Drainage, as mentioned before, is, generally speaking, good throughout the Province, and as it is the custom to plough up all fallow land after the rains conservation of moisture is fairly well secured.

Manuring

28. Although it is recognised that the sugarcane crop requires a special manuring of its own, the whole question is so involved with that of the general fertility of the soil that it is impossible to compare the various practices of cultivators without reference to the treatment of the land throughout the rotation. Where sugarcane forms part of the usual crop rotation, as it does in all the important cane districts, the practice is to consider it the most important crop of the series and to give it the first consideration with regard to manure, the other crops being considered subsidiary in their manurial requirements. We thus find that in the majority of places most of the available manure goes to the sugarcane crop. Further, the crop as a rule is given the benefit of a fallow of not less than ten months.

Sengi as a fertilizer

29. Where the cane crop follows a *kharif* crop, it is the practice in some places as mentioned above to grow a catch crop of *sengi*, which is subsequently grazed off for manurial purposes. It is important to observe that in this case cultivators hold that no other manure is required. This practice would seem to indicate a great power of expansion of the manurial supply of the Province if necessary. At the same time it must be noticed that such land probably gets some manure at some stage of the rotation or other. But the point is well worthy of consideration, as in the cane-growing districts the area under the crop is probably mainly influenced by the supply of manure and water. This practice also admits of the abolition of the long fallow and the possibility of cane following cotton (a *kharif* crop), which would doubtless add to the economic value of the crop in the rotation.

The chief source of manure is of course farm-yard manure. Cakes as far as I know are not used, but occasionally crude saltpetre and nitrous earth, where available, are applied.

Quantity of manure

30. The amount of manure supplied varies considerably and depends on local circumstances. Close to the hills some land receives an annual supply of river silt and requires no manure. But these cases are exceptional and the crop in general receives from 150—300 maunds (82lbs.) per acre of farm-yard

manure. Some cultivators hold that an excess of manure spoils the quality of the juice. This may be probably explained by the tendency of an overdose of manure to retard the ripening of the crop.

Time of application.

31. Manure is generally applied when the final preparation of the land before planting is begun, say a month before. It is customary in some cases, where the supply at that time is deficient, to apply a second dose after the cane has appeared above the ground. The manure is generally in this case worked into the soil in the process of weeding. As a general rule, however, all the manure is applied before sowing.

Available manure in the Province

32. In discussing the quantity and quality of the available manure in the Province it is worth while considering the influence of climate. It is quite probable that owing to the colder winter climate and the short duration of the monsoon both the quantity and quality will compare unfavourably with other Provinces. It is probable that more cattle-dung is used during the cold weather in this Province than in others. The rains prevent the use of cattle-dung as fuel to a large extent during their duration and the comparative dryness of the Province must act adversely to the accumulation of manure.

The trash and leaves of the cane are all lost to the manure heaps as it is required for *gur*-making. The stools, too, are often burnt and this residue is thus lost to the soil.

Residue of leguminous crops

33. The practice of ploughing leguminous crops into the land under fallow in the hot weather, although not necessarily before sugarcane, comes under the heading of manuring. This practice is met with mainly, I think, in Jullundur where the cultivation is, generally speaking, excellent. The usual crop used for this purpose is *san* hemp. The great drawback the cultivators experience is the difficulty of ploughing in such crop properly with their *desi* ploughs. A shallow draught furrow-turning plough would be very useful for this purpose.

It must also be taken into consideration that in the sugarcane-growing tracts the leguminous crops—*san*, *mash* and *mung*—are widely grown and the value of their manurial residue must be considerable.

Oil-cakes

34. Regarding the supply of oil-cakes for manure in the Province I have not been able up to the time of writing, to obtain any figures dealing with the total amounts. The oil seed crops form an important item in the *rabi* crop of the Province. *Sarson* (rape) and *toria* (mustard) are the two chief varieties grown, others being rockel (*taramira*), sesamum (*til*) and castor. An analysis of the cakes from these crops is given in Table IX.

Manurial experiments

35. Unfortunately no manurial experiment dealing with sugarcane of any value has hitherto been carried out in the Punjab. In 1904 the Lyallpur Station took up one experiment, but its value was lost owing to the attack of borers. The result is given in the Station Report for that year, but must be largely discounted.

Expansion of manure supply.

36. It may be said that the Province in one way and another has considerable manurial resources capable of expansion. The most valuable and probably the cheapest sources lie in the possibility of growing leguminous catch crops, the development of which has not been attempted.

Value of suitable rotations.

37. Any attempt to increase the area under sugarcane by manurial expansion ought to take into consideration the possibility of working out a scientific rotation of crops culminating in sugarcane. Such a series ought to include if possible at least one other paying crop such as cotton, at least one leguminous crop, and finish up with a catch crop of, say, *sengi*, before sugarcane. This is practically the practice of many of the best Jullundur cultivators, but whether it would prove suitable for other districts remains to be seen It is just possible that the land of other districts, where the *kharif* fallow system is carried out, may not be able to do without the fallow, but where possible it certainly *primâ facie* looks like good economy.

38. After cultivation consists mainly of weeding and hoeing and it is generally recognised that the more often this can be done the better for the crop. Four hoeings and weedings are considered quite necessary and as many more as possible. In good cultivation an average will possibly be six weedings and two hoeings.

After cultivation

Weedings for the purpose of cleaning and loosening the soil are performed by means of the trowel-like hand implement called the "baguri" or "khurpa." Hoeings for the purpose of breaking up the hard surface are done with the *kahi* which consists of a broadish iron blade fastened at an angle of about 60° to a wooden handle.

Improved cultivators are unknown.

The land is seldom protected from the rays of the sun during the early days of the life of the crop, but this is sometimes done, especially at Hoshiarpur, by laying down the leaves of the Chhachra (*Butea frondosa*). After the canes attain a height of a few feet it is impossible to penetrate into the plots and all cultivation ceases.

39. The only treatment during the growth of the crop is tying which although more commonly done in the Delhi Division is known all over the Province. As far as I know bamboos are seldom used for this purpose, although it is usually done for the sake of supporting the crop. The common practice is to tie two or three canes together by their leaves Nothing is done in the way of treating the canes to keep off jackals, etc., watching and making noise by night being the only attempts to guard against their attacks.

After treatment.

40. It is the usual custom to irrigate up to the time of cutting. This practice is believed by cultivators to increase the amount of juice and to be a protection against frost.

41. Very little is known in this Province about the sugarcane diseases. What is known is merely the knowledge of the cultivators themselves. The chief insect pests are the moth-borer and white-ants, more especially the latter, which are responsible for a good deal of the damage done to the crop.

Diseases and insect attacks

Cultivators say that *tela* (*aphis*) does some damage, but I find that the term *tela* is very often used to denote any form of disease. *Red smut* is known, but I doubt if the damage done by this disease is fully appreciated.

Black smut occurs occasionally but is rare.

Arrested growth is said to occur sometimes, but I have not seen it. It is said to be due to drought which is doubtful as it is confined to a few plants in a whole field.

As a rule fungoid diseases are, I think, comparatively rare, soil and weather conditions being unfavourable for their development. The climate is generally speaking dry and the drainage good

Animal attacks are general all over, jackals and rats being perhaps the most serious, others being monkeys and wild boars.

42. The fact that deterioration rapidly sets in after cutting is thoroughly well understood and the custom is to take the canes direct to the mill. In fact the cutting forms part of the *gur*-making operations and goes on at the same time.

Deterioration of the juice after cutting.

43. Canes are usually cut at the ground as low as possible, and this is always done at one operation, the tops being removed after reaping. There is practically only one type of cane grown in the Province, and I know of no local variations of these rules.

Cutting.

44. The yield per acre in *canes* is not usually calculated by the cultivator, but the Lyallpur Station experimental weighings give some idea of the yield per acre in canes and also of the percentage of *gur* to cane.

Yield per acre in canes.

45. The cultivator invariably manufactures or partly manufactures his own produce. Canes, except the *paunda* varieties, are never sold as such.

Manufacture.

The two chief products are *gur* and *mal rab*, the latter being generally sold to the sugar manufacturers. The process in the manufacture of *gur* and *mal rab* being practically the same, a description of *gur*-making will be sufficient to indicate the character of the manufacture of both products in the Province

46. It may be said at the outset that the *gur*-making methods vary very little throughout the Province, any difference being generally due to the skill and industry of the individual *gur*-maker.

Methods vary very little.

47. The two kinds of cane-pressing mills in use are the *belna* and iron roller mill. Both are too well known to need any description. The iron roller mill has come largely into use and is generally recognised by the cultivator to be quite a success. Some districts still hang on to the *belna* mill. These tracts are mostly in the districts irrigated by Persian wheels where the cultivator has been in the habit of using the trash of the cane for rope making. It is acknowledged by the users of the iron mill that it expresses 10 per cent. more juice and costs about one-half the labour of the *belna*. In the face of this it is difficult to see how the argument for the "belna" can be maintained, but it is probably only a matter of time until the use of the iron roller mills becomes universal The mills as a rule either belong jointly to several cultivators or are hired by them for the season.

Cane presses.

48. The canes are cut and stripped by men who receive as payment for their labour the tops and a few whole canes.

Pressing and collecting

The expressed juice flows into either a large jar or is collected by several small jars. These jars are made of earthenware, but I have heard of cases where old *kerosine-oil tins* have been used.

49. When sufficient juice has been expressed it is poured into the boiling-pan, being strained either over the fire or before it is put on the fire. The most common practice is to have only one boiling pan, but in some places batteries of two are used, one, the cooler one, being raised a little higher than the other.

Boiling.

While the juice is being boiled the scum is removed by ladles and either thrown away, given to sweepers or fed to bullocks Where *mal rab* is the product aimed at, the juice is generally cleared by using a preparation of the bark of the *sukkai* tree. Sometimes also the root of the *bhindi* plant is used for this purpose and in rare cases liming is carried out. Milk also is sometimes added after about two hours' boiling. When crystals appear, if *rab* is wanted, the boiling mass is emptied into clear earthen vessels called *mattis*, while if *gur* is desired boiling is continued until all the water has disappeared and the mass is of a thick curdlike consistency.

50. The proper moment for ceasing boiling in both cases is merely judged by the *gur*-maker himself: no tests are employed except to see roughly the state of the mass by taking out a small quantity with the fingers. The boiling *gur* is emptied into a shallow circular earthen pan called *gand*. The mass is stirred for a few minutes by a *khurpa* and then allowed to cool.

Cooling

51. After cooling, the *gur* is collected into the centre of the *gand*, beaten between the hands, and made into sound balls, in which shape it is sold in the market.

Beating the *gur*

The jaggery as a rule has to be sold at once, but the purchaser is usually on the spot.

52. The whole process goes on simultaneously through day and night. As one boiling is finished, a new lot of juice is ready. The juice thus stands no longer than the time of boiling (2—2½ hours). Collecting pans where used are not heated.

Gur-making a continuous process

53. As a rule the leaves and trash are sufficient for fuel, but occasionally where the *belna* mill is used and some of the trash is used for rope-making, extra

Fuel.

fuel in the shape of wood, cowdung, or cotton stalks has to be used. It may be said in any case that no residue gets back to the field for manure.

54. Liming is comparatively rare. I am not in a position to say whether it is done completely or not.

Liming.

I am not aware of any process used for preserving jaggery.

55. Table IV gives the average monthly retail prices of *gur* in the Punjab for the years 1901—1905. The average works out at about R4-8-0 per maund of 82 lbs. The cheapest time is of course during and after the *gur*-making season. The price usually is at its maximum in September and October just before cutting time.

Price of gur in local markets.

56. The cultivator as a rule sells his *gur* when it is ready for the market and so does not benefit by the rise in price which takes place later on. As a rule he considers R3-8-0 to R4 a good price for good *gur* at marketing time.

57. In the principal cane tracts the supply of *gur* is greater than the demand and the surplus *gur* goes to those parts where cane-growing is less important. In the Punjab a ready market is always obtainable within the Province.

58. *Profit and Loss Account of Sugarcane cultivation in the Province.*—I have the greatest suspicion of such calculations which are after all only estimates. It is no doubt quite possible to give a statement of the cost of cultivation in particular instances and even to give an average cost of production in different localities. But the cost of production, calculated on the basis of hired labour, may easily vary to the extent of R10 per acre which in many cases is equal to the net profit.

A record of the actual nett revenue from the crop of one piece of land for a number of years would really be of use, but unfortunately we have no such record.

I append the actual cost of production at the Lyallpur Agricultural Station with the ordinary *desi* cultivation calculated on a hired labour basis—

	R	a.	p.	R	a.	p.
I. *Cultivation*—						
Ploughings	8	0	0			
24 carts manure (300 maunds)	12	0	0			
Seed (bought)	12	0	0			
Sowing	2	0	0			
Weeding with *khurpa*	6	0	0			
Hoeing with *kahi*	2	0	0			
Irrigation expenses	2	0	0			
Water rate, etc.	10	0	0			
	54	0	0	54	0	0
II. *Manufacture of gur*—						
*Trashing	30	0	0			
Pressing	25	0	0			
Gur-making	7	8	0			
	62	8	0	62	8	0
				116	8	0
				per acre.		
Revenue.						
30 maunds *gur* at R3-8-0 per maund	105					
*Value of tops, etc (given to trashers)	30					
	135					

leaving a profit of R18-8-0 per acre.

*This is the usual practice.

The price of seed given above is, I think, excessive. The writer has a number of such calculations made at Jullundur, Phillour, Hoshiarpur, Karnal and Rohtak, but considers that they are not reliable enough to publish. The cost of *gur*-making, however, in each case is about the same, *viz.*, R1 per maund of *gur*.

Probably the Lyallpur figures represent about a fair average throughout the Province.

Other saccharine product.

59. The other saccharine products from sugarcane are—

(1) *Shakar*, which is simply *gur* finely ground.

(2) *Khand*, the drained raw sugar obtained from *mal rab*. The process is as follows. The *rab* is emptied into large *kachha* vats lined with matting holding from 100 to 400 maunds. At the bottom of the vat is placed a mat constructed of reeds resting on bricks 8 or 9 inches high or on wooden supports. Over the reed matting a piece of coarse cloth (*pal*) is spread. The bottom of the vat is drained into reservoirs to hold the molasses. The molasses called *Shira* are frequently collected in earthen jars. The *rab* having been poured into the vat or *khanchi* is left for 3 weeks or a month. After the molasses have drained away the mass which remains is covered with a water weed called "*jala*" to the depth of a few inches. This is changed every day for about a fortnight. The mass gradually becomes clear and takes on a lightish colour at the top. This is removed and the remainder covered up again. The stuff removed is put in the sun and worked with the feet. It is now *khand*.

(3) *Misri* is prepared from *khand* by boiling it with water and a little milk. The scum is removed and the liquid poured into earthen or metal vessels where the *misri* crystallizes. The quantity of water added seems to vary considerably from one-fourth to an equal quantity of the *khand*.

(4) *Bura*, a superior form of *misri*, is obtained from *khand* by boiling it as for *misri*. The syrup is removed from the fire and stirred with two wooden instruments called *mosads*. The substance is sifted and powdered.

(5) *Taviki misri* is the usual *misri* obtained by pouring the purified *khand* into an iron tray.

(6) *Kuza misri* is obtained by pouring the purified *khand* into small earthen bowls where it is permitted to stay for a week. Some *shira* is extracted and the mass is now *kuza misri*.

Improved machinery.

60. Little has been hitherto done in the way of introducing improved machinery for sugar-making into the Province. At present only one factory exists. It is situated in the Gurdaspur District. After a chequered career, during which it was found to be impossible to make the concern pay as a sugar factory pure and simple, it has combined the business of a soda-water factory and has been lately paying 10 per cent. on capital. The factory deals with *rab* which is obtained from the cultivator.

Suggested improvements. New varieties.

61. *Introduction of new varieties.*—This has been attempted but in a spasmodic fashion owing to the want of an organised Agricultural Department. This difficulty, however, will soon be overcome especially as the new agricultural station at Jullunder is in the heart of the cane-growing districts.

Improved cultivation.

62. This point can only be settled by actual trials on experimental stations. It is too early to say whether improved cultivation may be an economic success or not.

Irrigation facilities

63. The canal irrigation system of the Punjab has been and is still being enormously developed. The question of increased well-irrigation by oil-engines and other motor powers is under consideration by the Agricultural Department. A very large increased area of land will thus have a regular water-supply and it is possible that a considerable proportion may eventually become cane-yielding.

Improved methods in manufacture.

64. Probably we may look for more improvement in the manufacture of *gur* and *rab* than in any other direction. The existing methods are crude and very

probably wasteful. It is possible that instructions in better methods might be of great assistance to cultivators. This might possibly be undertaken at the new Jullundur station.

Small plants.

65. With regard to the introduction of small plants for sugar-making the writer has really too little acquaintance with the customs and practices of the country to express a definite opinion. There is little doubt, however, but that small concerns would have a better chance than large ones. Possibly there might be a chance through village co-operation in the matter. The small native sugar refineries are in the hands of the *banias* at present, who doubtless make a handsome profit. It has been stated that the decline of "*rab*-making" in some districts is due to that fact.

Factories producing sugar from cane.

66. It is difficult to say whether it would be better for one factory to produce the sugar from the raw material or to buy the product of the cultivator for that purpose.

Objections.

67. The fact that the *rab*-making process is profitable and leaves the cultivator a good price for his labour would seem to be averse to the former proposal. The question of transport would also be unfavourable.

Government aid.

68. The question of Government aid cannot at present be discussed. The whole question requires first of all to be gone thoroughly into, and that has not been done. Experimental work will be undertaken at the Jullundur station when it is established, but until then little work of any value can be accomplished.

S. MILLIGAN,

Deputy Director of Agriculture, Punjab.

TABLE I.

Average monthly rainfall at Head-quarters of each District in the Punjab.

Division.	Number.	District	January.	February	March	April	May.	June.	July.	August	September	October.	November.	December	Total average rainfall in a year.
Delhi.	1	Hissar	0·66	0·42	0·50	0·22	0·66	1·87	4·63	4·25	2·03	0·27	2·07	0·43	16·01
	2	Rohtak	0·82	0·59	0·54	0·34	0·72	2·68	5·91	5·66	3·21	0·34	0·03	0·51	21·22
	3	Gurgaon	0·88	0·41	0·49	0·16	0·68	2·75	8·39	7·10	4·32	0·34	0·04	0·34	25·92
	4	Delhi	1·02	0·61	0·67	0·35	0·71	3·18	8·38	7·44	4·42	0·39	0·10	0·43	27·70
	5	Karnal	1·28	1·16	0·73	0·41	0·97	4·11	9·40	6·90	4·60	0·37	0·12	0·50	30·55
	6	Ambala	1·53	1·58	0·86	0·55	0·86	4·09	11·01	8·74	4·50	0·44	0·24	·87	35·07
	7	Simla	3·21	3·07	2·48	2·32	3·71	7·81	18·42	17·87	6·17	1·19	0·41	1·28	67·97
Jullundur.	8	Kangra (Dharmsala)	4·89	4·88	3·67	1·95	2·58	11·04	40·81	39·19	12·44	1·32	0·35	0·57	125·69
	9	Hoshiarpur	2·42	1·89	0·92	0·47	0·71	3·91	9·84	9·35	4·79	0·29	0·10	1·24	36·00
	10	Julundur	1·52	1·25	1·08	0·58	0·73	2·81	7·76	7·30	3·41	0·38	0·09	0·71	27·64
	11	Ludhiana	1·14	1·11	1·14	0·65	0·85	3·56	8·61	6·59	3·70	0·81	0·06	0·73	28·25
	12	Ferozepore	1·11	0·86	0·66	0·51	0·57	3·28	6·32	4·86	2·41	0·51	0·05	0·47	20·61
Lahore.	13	Montgomery	0·53	0·60	0·42	0·21	0·39	1·12	2·86	2·72	0·91	0·13	0·05	0·27	9·84
	14	Lahore	0·87	1·13	0·89	0·51	0·80	1·86	6·65	4·88	2·10	5·13	0·11	0·47	20·70
	15	Amritsar	1·76	1·14	0·86	0·41	0·68	2·57	7·03	7·33	1·69	0·26	0·06	0·50	24·29
	16	Gurdaspur	3·18	1·87	1·41	0·57	0·97	4·16	9·90	8·71	3·63	0·49	0·14	1·09	34·04
	17	Sialkot	1·91	1·85	1·58	1·27	1·05	2·98	10·30	9·74	2·99	0·49	0·26	0·77	35·22
	18	Gujranwala	1·14	1·41	1·17	0·70	0·77	1·86	7·35	6·11	2·14	0·41	0·20	0·62	24·18
Rawalpindi.	19	Gujrat	1·90	1·52	1·76	1·02	0·74	2·38	7·56	6·04	2·41	0·42	0·05	0·07	27·84
	20	Shahpur	0·82	0·95	0·95	0·62	0·68	1·18	3·76	3·07	1·50	0·15	0·22	0·38	14·28
	21	Jhelum	1·96	1·38	1·56	1·10	0·87	2·00	7·39	6·39	2·34	0·45	0·24	0·80	26·38
	22	Rawalpindi	2·50	2·10	2·09	2·05	1·12	1·79	8·31	7·71	3·18	0·53	0·04	1·11	33·36
	23	Attock	2·17	1·95	1·67	1·11	0·63	0·52	3·57	3·98	2·02	0·18	0·30	0·59	18·69
Multan.	24	Mianwali	0·77	0·78	0·79	0·77	0·62	0·81	2·95	2·62	0·91	0·05	0·28	0·20	11·55
	25	Lyallpur	0·41	0·72	0·71	0·08	0·42	0·84	2·39	1·13	1·68	0·12	0·17	0·13	9·09
	26	Jhang	0·51	0·45	0·71	0·36	0·19	1·03	3·32	2·18	0·84	0·14	0·06	0·31	10·23
	27	Multan	0·39	0·36	0·42	0·27	0·39	0·13	2·19	1·66	1·00	0·07	0·06	0·27	7·11
	28	Muzaffargarh	0·33	0·35	0·35	0·33	0·31	0·35	1·36	1·42	0·52	0·09	0·08	0·27	5·78
	29	Dera Ghazi Khan	0·41	0·45	0·56	0·33	0·15	0·47	1·93	1·28	0·45	0·05	0·11	0·26	6·39

TABLE II.

Showing the area of the sugarcane crop of the Punjab for the last five years, i.e., from 1901—05.

(HARVESTED AREA)

Division	Number.	District.	Area under sugarcane in—					Average,* 1901—04.
			1901.	1902.	1903.	1904.	1905	
DELHI.	1	Hissar	1,101	770	741	294	115	729
	2	Rohtak	21,730	18,117	19,994	24,434	5,403	21,171
	3	Gurgaon	9,477	5,187	7,630	7,557	485	7,643
	4	Delhi	17,271	17,512	16,350	17,575	7,959	16,927
	5	Karnal	19,541	20,766	19,322	19,553	11,348	19,795
	6	Ambala	8,523	10,377	12,350	15,870	10,001	11,855
	7	Simla	...	...	...	...	...	...
JULLUNDUR.	8	Kangra	5,667	4,982	4,769	4,829	2,806	5,061
	9	Hoshiarpur	21,074	22,114	24,148	24,021	17,507	22,839
	10	Jullundur	30,010	31,632	31,181	27,797	10,440	30,162
	11	Ludhiana	12,498	11,896	11,465	9,692	6,381	11,139
	12	Ferozepore	3,966	3,103	2,109	1,507	1,039	2,671
LAHORE	13	Montgomery	1,008	582	435	411	366	608
	14	Lahore	6,832	6,055	6,176	6,504	2,799	6,579
	15	Amritsar	20,146	16,615	17,038	16,545	4,104	17,493
	16	Gurdaspur	49,917	48,231	52,612	51,590	28,260	50,567
	17	Sialkot	36,690	30,546	32,135	34,010	23,491	31,570
	18	Gujranwala	30,071	22,174	19,762	20,492	9,569	23,349
RAWALPINDI.	19	Gujrat	7,833	7,161	6,406	6,691	5,501	6,998
	20	Shahpur	1,448	1,074	1,500	2,641	1,523	1,665
	21	Jhelum	304	312	265	233	236	281
	22	Rawalpindi	104	158	126	116	135	181
	23	Attock	7,624	1,792	1,650	1,557	1,703	1,630
MULTAN.	24	Mianwali	43	49	70	103	113	66
	25	Lyallpur	37,653	28,683	33,358	30,672	6,842	32,566
	26	Jhang	5,483	2,134	1,711	459	248	2,672
	27	Multan	1,079	1,370	1,015	1,141	832	1,157
	28	Muzaffargarh	4,663	6,500	5,762	5,392	4,575	5,594
	29	Dera Ghazi Khan	54	51	78	83	65	77
		TOTAL	356,017	320,258	330,767	333,231	155,405	337,301

* The year 1905 being exceptional is omitted from averages.

TABLE III.

Percentage of Sugarcane to cultivated area.

Name of District.	Percentage	Remarks.
Hissar	·00	District poor, rainfall 15 inches.
Rohtak	3·8	
Gurgaon	·98	Insecure.
Delhi	3·5	
Ambala	2·5	
Kangra	·73	Hill district.
Hoshiarpur	2·8	
Jullundur	3·9	
Ludhiana	1·5	
Ferozepore	·0	Dry, rainfall 11 inches
Montgomery	·13	Very dry, rainfall 8·5 inches
Lahore	·6	
Amritsar	2·0	
Gurdaspur	5 6	
Sialkot	3 7	
Gujranwala	2 4	
Gujrat	·9	Rawalpindi Division colder with shorter season.
Shahpur	·2	
Jhelum	·00	
Rawalpindi	·00	
Attock	·2	
Mianwali	·00	Poor district very dry
Lyallpur	2 6	Slight rainfall, irrigation good
Jhang	2	
Multan	17	Dry
Muzaffargarh	1 2	Do
Dera Ghazi Khan	·00	Do
Average for the Province	1·7	

TABLE IV.

Showing the average monthly wholesale prices of sugar (raw) at Lahore for the years 1901-1905.

Months.	1901.	1902.	1903.	1904.	1905.
	R a. p.	R a. p.	R a. p.	R a. p.	R a. p.
January	4 9 2	4 1 8	4 1 8	3 15 4	4 9 2
February	4 3 6	4 3 6	4 0 10	3 12 3	4 13 9
March	4 3 6	4 4 4	3 13 8	3 12 3	5 0 8
April	4 6 9	4 8 2	3 15 1	3 14 1	5 0 8
May	4 11 5	4 9 2	4 0 8	4 1 8	5 5 4
June	5 2 0	4 4 4	4 0 10	4 3 4	5 12 3
July	5 2 7	4 4 4	3 9 4	4 6 9	5 11 5
August	5 2 7	4 5 3	4 3 4	5 6 10	6 2 6
September	5 5 5	4 4 4	4 5 2	5 6 10	6 8 6
October	5 2 7	4 5 3	4 11 5	5 11 7	6 2 7
November	5 6 11	4 3 4	4 8 3	5 2 11	6 7 1
December	4 9 2	4 1 8	4 3 4	4 8 2	6 0 8

TABLE V.

Export of gur from the Punjab from 1896-1906.

Year.	By rail.	By land.	Total.	Remarks
	1,000 maunds	1,000 maunds.	1,000 maunds.	
	R	R	R	
1896-97	450	120	570	Expressed in thousands of maunds. 1 maund = 82 lbs. nearly.
1897-98	810	90	900	
1898-99	570	120	690	
1899-1900	420	130	550	
1900-01	600	140	790	
1901-02	350	500	850	
1902-03	280	130	410	
1903-04	370	110	480	
1904-05	570	110	680	
1905-06	210	110	320	
Ten years' average	463	156	619	

TABLE VI.

Imports of gur and sugars into the Punjab for 1896-1906.

Year.	Sugar refined.	Sugar unrefined.	*Gur*, etc	Total	Remarks.
	R	R	R	R	
1896-97	770	* 1,130	...	1,900	Expressed in thousands of maunds, 1 maund = 82 lbs. nearly.
1897-98	960	* 1,360	...	2,320	
1898-99	800	* 1,500	...	2,300	
1899-1900	680	720	1,160	2,560	
1900-01	1,030	370	680	2,080	
1901-02	1,360	640	1,280	3,280	* No distinction made up to 1899-1900 between *gur* and unrefined sugar.
1902-03	900	770	1,380	3,050	
1903-04	1,350	810	1,060	3,220	
1904-05	1,220	810	1,080	3,110	
1905-06	2,160	840	2,450	5,450	
Average for 10 years	1,128	904	909	2,936	

TABLE VII.

Estimated consumption of sugar products in the Punjab for the years 1896-1906.

	1896-97	1897-98	1898-99	1899-1900.	1900-01.	1901-02	1902-03	1903-04	1904-05	1905-06	Remarks.
Estimated home production.	8,890	7,560	8,010	8,290	7,610	8,530	7,460	7,720	7,770	3,140	Reckoned in thousands of maunds —1 maund=82 lbs. nearly.
Imports . . .	1,900	2,320	2,390	2,560	2,080	3,280	3,050	3,220	3,110	5,450	
Total . .	10,790	9,880	11,300	10,850	9,690	11,810	10,510	10,940	10,880	8,590	
Deduct—Exports .	570	900	690	550	740	550	410	460	680	320	
Total home consumption	10,220	8,980	10,610	10,300	8,950	10,960	10,100	10,460	10,200	8,270	
Deduct—Refined sugars	770	960	800	680	1,080	1,360	900	1,350	1,220	2,160	
Consumption of *Gur* and unrefined sugar.	9,450	8,020	9,810	9,620	7,920	9,600	9,200	9,110	8,980	6,110	

TABLE VIII.

Analysis of oil cakes—Punjab.

	H. O	Ash	Sand	Oil	Woody fibre	Albud N.	Non albud N.	Total N.	Phos. acid
Rape (sarson) cake .	6·81	8·79	1·69	10·28	9·85	4·35	·31	4·66	2·58
Rocket (Tara Mira) cake	5·94	7·17	1·14	6·35	7·84	5·00	·37	5·37	..
Sesamum (Til) cake .	6·95	14·19	2·00	8·08	3·67	5·97	·32	6·29	...
Toria cake . . .	7·40	8·64	2·20	11·31	8·32	4·46	·29	4·75	...
Castor cake . . .	...	..	...	..	...	...	...	3·98	1·93

TABLE IX.

(*Extract from Lyallpur Farm Report* 1903-04)—*To show weight in lbs. of canes per acre and percentages*

Area sown in acres.	Manure applied	Method of cultivation	Description of method	Outturn per acre in pounds.			Percentage.			Green tops per acre.	Remarks
				Canes	Juice	Gur	Juice to Cane	Gur to Juice.	Gur to Cane		
¼th	Farmyard manure 100 lbs. N. per acre before sowing + oil-cake 50 lbs. N. per acre as a top dressing.	Behar System	Trenches about 14" deep are made 2½' apart. Cuttings are planted on both sides of the trench	20,048	12,028	3,218	60·00	27·00	16·20	8,780	
¼th		Mauritius System (modified).	Two cuttings are planted in each pit dug 3" deep and 2' apart between ridges made according to the Poona System	35,052	19,280	3,400	55·00	17·80	9·70	15,724	
¼th		Poona System	Ridges are made 2' apart in beds of 10' × 10', and cuttings are planted between the ridges.	33,736	16,296	2,800	48·30	17·33	8·30	14,520	
¼th		Ditto		22,510	13,372	2,112	59·32	18·00	10·70	8,852	The canes were trashed in the field 3 weeks before the harvest.
¼th		Country system	The cuttings are placed in the furrow behind the native plough, and the field is levelled.	39,776	23,520	5,008	59·3	21·3	12·6	18,010	

Note—Ploughing . 8 | Waterings .. 20
Weedings . 5 | Waterings (in the variety experiment) . 13

TABLE IX—(*Contd.*)

(Extract from Lyallpur Farm Report 1904-05)—To show weights in lbs. of canes per acre and percentages.

Area sown	Name of Variety.	Manure applied	Outturn per acre in lbs.			Percentage of.			Green tops per acre	Dry leaves per acre.	Remarks
			Canes.	Juice	Gur.	Juice to canes.	Gur to juice.	Gur to canes.			
									lbs	lbs.	
¼th acre each.	Katha Variety.	Castor cake 150 lbs. N. per acre before sowing.	14,500	7,372	1,310	5.084	9·21	18 17	9,568	...	Ploughings 1 Weedings 8 Waterings 13
		Rape cake 150 lbs N. per acre before sowing.	17,100	10,100	1,820	59 06	18 02	10 61	829	2,282	
		Farm yard manure 150 lbs. N. per acre before sowing.	4,772	3,080	601	77 11	16 41	12 05	2,364	792	
		Farm yard manure 100 lbs. N per acre before sowing and nitro 50 lbs N per acre as top dressing	10,896	10,028	1,760	50 40	17 55	8 84	9,508	1,838	
		Farm yard manure 100 lbs N. per acre before sowing and rape cake 50 lbs N. per acre as top dressing.	5,513	3,892	660	70 16	16 96	11·89	1,618	908	
		Farm yard manure 100 lbs N. per acre before sowing and castor cake 50 lbs N. as top dressing.	11,900	5,484	964	46 09	17·58	8·10	4,784	1,740	
		Unmanured	6,152	3,516	521	54·49	14·90	8 12	2,556	1,172	

Results of the Experiment with methods of cultivating sugarcane.

Area sown.	Manure applied.	Method of cultivation.	Description of method	Year.	Outturn per acre.			Percentage.			Green tops per acre.
					Cane.	Juice.	Gur.	Juice to cane.	Gur to juice.	Gur to cane.	
					lbs	lbs	lbs.				
¼th acre each.	Farm yard manure 100 lbs. N. per acre before sowing + Oilcake 50 lbs. N. per acre as a top dressing.	Behar system .	Trenches about 14 inches deep are made 2½ feet apart. Cuttings are planted on both sides of the trench.	1903-04	20,013	12,028	3,248	60 09	7 00	16·20	8,780
				1904 05	16,964	8,276	1,344	49·84	6 24	7·93	13,503
		Mauritius system (modified)	Two cuttings are planted in each pit dug 3 inches deep and 2 feet apart between ridges made according to the Poona system	1903-04	35,052	19,290	3,400	55·00	17·80	9 70	15,724
				1904 05	7,320	3,480	576	47·54	16 55	7·87	6,196
		Poona system .	Ridges are made 2 feet apart in beds of 10′ × 10′ and cuttings are planted between the ridges.	1903 04	33,736	16,296	2,800	48 30	17·83	8·30	14,520
				1904-05	12,460	7,024	1,164	56·37	16·67	9·34	1,934
		Ditto .	As above, but the canes are trashed 3 weeks before harvesting	1903-04	22,540	10,372	2,412	5 0 32	18·00	10 70	8,852
				1904 05	8,610	4,268	688	49 59	16·12	7·99	4,436
		Country system	The cuttings are placed in the furrow behind the native plough and the field is levelled.	1903 04	30,776	18,520	5,008	59 80	31·30	13 60	8,040
				1904 05	11,900	5,484	904	46 09	17 58	8·10	4,784

Ploughings 9; Weedings 4; Waterings 20—21.

Burma.

This note follows, as far as possible, the lines indicated in Mr. Barber's "Scheme for Provincial enquiry into the Sugarcane Industry," and the sections follow the paragraph numbers of Mr. Barber's paper.

1. It may at the outset be said that if India has certain advantages over other sugar-producing countries, such as its cheap and abundant labour, *etc.*, the scarcity and consequent dearness of labour in Burma put it at a great disadvantage in sugarcane as in all other products in which it must compete with India, and for which it has not a specific market of its own. A low rate of cooly hire in Lower Burma is 8 annas a day or R15 per mensem, and subject to correction, I imagine that this is very much higher than the labour rate in other sugar-growing parts of India. The rates for labour to manufacture the sugar would be proportionately in excess, so that, as a commercial venture, sugar is not likely to take much hold in Burma.

2. *Climate.*—The principal sugarcane-growing districts of Burma are—

Amherst, Thaton and Toungoo in Lower Burma and Yamethin and Kyaukse (rather for quality than quantity) in Upper Burma.

The following statement shows the maximum and minimum thermometer readings at the recording stations in these districts for the year 1905 :—

Statement showing the Minimum and Maximum Thermometer's readings at the recording stations of Amherst, Thaton, Toungoo and Yamethin by months for the year 1905.

	January.	February	March.	April	May	June	July	August	September	October	November	December.
AMHERST (MOULMEIN)												
Dry minimum thermometer	64 12	65 1	73 6	76·7	76 9	74 64	74 20	74 07	74 20	75 30	70·10	69 80
Dry maximum do	87 84	91·7	92 8	94 7	92 7	82 72	82 10	81 00	83 80	83 60	87 10	90 10
THATON.												
Dry minimum thermometer	54 23	61·21	68 32	66 27	72·81	72·53	72 55	73 16	73 57	71 16	70 67	67 90
Dry maximum do.	83·61	87·64	91 39	93 77	91·00	82·10	79 03	80 42	80 97	85 26	86 37	85 97
TOUNGOO.												
Dry minimum thermometer	55 97	59·61	69 96	73 72	77 13	75 16	75 34	74 57	75 30	75 60	69 53	60 83
Dry maximum do	83 96	89 39	96 06	61 60	99·09	89 12	87 13	87 03	87·40	89 60	86 20	82 50
YAMETHIN.												
Dry minimum thermometer	55 06	59 07	72 09	74·04	76 93	75 86	75 00	74 28	74 43	74 37	67 71	59 01
Dry maximum do	82 90	87 36	93 77	98 84	98·31	90 71	87 68	87 73	87 77	88·91	85·37	80·91

Rainfall.—The following statement shows the recorded rainfall by periods for each of the districts specified for the year 1905 :—

Districts.	From 1st January to 31st March	From 1st April to 30th June.	From 1st July to 30th September	From 1st October to 31st December	Total.
	Inches.	Inches	Inches.	Inches.	Inches.
Amherst (Moulmein) . .	0	62·39	104·49	11·31	178·19
Thaton	0	84·17	140 49	7·25	231·91
Toungoo	0 60	24·55	54·38	9·77	89·30
Yamethin	1·07	8·05	18·86	7·74	35·72
Kyaukse	2·58	4·93	13·60	7·56	28·62

3. *The age of sugarcane cultivation in Burma.*—It is difficult to trace the past history of sugarcane cultivation in Burma. The principal sugarcane tract of Burma has always been the Bilin township of the Thaton District, and writing of it in 1882 Mr. J. E. Bridges, I.C.S. (retired), says: "In Burmese times there were small patches of black cane grown round Bilin and sugar was manufactured in small quantities. Shortly after the English took the country the 'Madras cane' was introduced from Moulmein, and it is now the cane almost exclusively grown in this tract." This is the only reference of any value that I can trace.

4. *The extent and character of cultivation.*—The following statement shows by districts the total area under sugarcane in 1906 :—

District.	Area.	District	Area.
	Acres.		Acres.
Akyab	261	Amherst	688
Kyaukpyu	603	Tavoy	62
Sandoway	705	Mergui	81
Hanthawaddy	131	Thayetmyo	24
Pegu	182	Pakokku	30
Thatawaddy	557	Magwe	1
Prome	307	Mandalay	2
Maubin	127	Bhamo	8
Pyapon	104	Myitkyina	10
Bassein	185	Katha	2
Henzada	157	Lower Chindwin	2
Myaungmya	447	Upper Chindwin	5
Toungoo	1,368	Kyaukse	381
Salween	149	Meiktila	253
Thaton	4,291	Yamethin	1,587
		TOTAL	12,710

The total Provincial area for the past five years has been—

Years.	Acres.
1901-02	15,285
1902-03	16,277
1903-04	13,108
1904-05	11,303
1905-06	12,710
TOTAL	68,683

It will be noted from the above statements that the cultivation is scattered in small areas over many districts and that only in three is there an area of over 1,000 acres. The total, never great, shows evidence of shrinkage; but this is so small and the total area affected so insignificant that no particular reason can be assigned. It may be noted that Mr. Bridges found 3,753 acres under sugarcane in Thaton in 1882, so that there has been some increase there.

General character of the cultivation.—In newly cultivated tracts in Lower Burma it is a common practice to take a small crop of sugarcane off newly cleared land preparatory to laying out the land in continuous paddy. This is generally on a patch of about an acre or so near the river bank, and, in fact, in most districts of Lower Burma this is about the extent of the cultivation. In the Bilin township of Thaton District, however, Mr. Bridges found cane cultivation pretty constant on one piece of land with fallowing every second or third year; in some cases the fallow area being planted out in paddy with sufficient spaces between the paddy to allow of cane tops being laid down in September. In this same tract in 1897 it was found by the Settlement Officer that as a rule only half a holding is worked annually, the other half being fallowed for about ten months, *i.e.*, between the cutting of the crop and the preparation of the land for the new one. In Yamethin, Upper Burma, sugarcane rotates with early sessamum every alternate year, the period of fallow being three to four months in the year, *i.e.*, between the reaping and sowing of the respective crops.

In Toungoo sugarcane is either grown in the ordinary method of Lower Burma without irrigation or manuring or on high poor land of sandy loam which is well manured and irrigated from a surface tank or well. As a rule this land is deteriorated paddy land, but after a sugarcane crop has been taken off, the treatment which the land has received to produce this crop leaves sufficient fertilising material in the soil to give a good crop of paddy and it reverts to its original crop for two or three years.

In Kyaukse sugarcane, with the other crops of the district, receives the benefit of the elaborate system of irrigation which the district enjoys. Sugarcane generally follows Goa beans, is always irrigated, and is only planted over in three years on the same soil. In Moulmein and in a few other districts we find both methods—the casual shifting cultivation and the permanents.

Relatively the permanent method of cultivation found in Thaton is considered the most important. The small areas recorded against other districts are simply small patches on the borders of creeks planted with coarse sugarcane which is only used as a sweetmeat and not manufactured. The bulk of the sugarcane of Burma is so used.

Origin of the soil.—Mr. Bridges thus describes the soil in Bilin :—

"The soil of the valleys of the Bilin and Thebyu rivers is almost entirely deep grey loam, mixed here and there with light clay. The land is covered by the floods for a few days at intervals during the rains to a depth of two or three feet and a thick layer of alluvial soil deposited on it." The Settlement Officer in 1897 says that: A sandy silt is preferred for cane cultivation. Given this soil over a good clay, the outturns are as a rule good. The rivers overflow their banks two or three times every season, thus giving the necessary amount of water to the plants and at the same time making fresh deposits. Cane is also grown on higher land when they depend on rain. In Toungoo *sandy loam is the favourite soil. In general the favourite soil is either deltaic* or alluvial formation revived from time to time by silt deposits. I am sorry that the short time at my disposal has prevented me from making the collection of soils suggested.

5. *Varieties of cane grown.*—I note on this with diffidence as I have no botanical adviser. Mr. Bridges noted the following :—

(1) Black cane (in Burmese times).

(2) Madras cane introduced shortly after we took the country, of yellowish colour and so flexible that it does not require any supports. It grows to a height of 10 to 12 feet. Percentage of sugar in juice by saccharometer ranges from 20 to 27·14. Percentage of coarse sugar in juice ranges from 12·52 to 17 per cent.

(3) The "*Kaing Kyan,*" so called from its resemblance to *Kaing* or elephant grass. Whitish in colour, and grows to same height as Madras cane, but is much thinner. Also flexible and does not require supports. Juice contained 21·43 per cent of sugar by saccharometer and 13·42 per cent of coarse brown sugar according to actual experiment.

(4) The "*Anyagyan*" or Upper Burma cane, reddish in colour with short thick joints: 20 per cent. of sugar by saccharometer: 12·52 per cent. of coarse brown sugar.

(5) The "*Kyoukgoung-gyam*"—Large cane of greenish colour with short thick joints: 14·28 per cent, of sugar by saccharometer: 8·94 per cent, of coarse brown sugar. It grows best in alluvial clay when it gave 22·85 of sugar by the saccharometer and 14·31 of coarse brown sugar.

Both these canes are very brittle and require supports. They are eaten as a sweetmeat and cannot be utilized for making sugar as they break at the joints while passing through the mill. These are probably the most popular canes and the most largely cultivated in Burma.

(6) The "*Kyannet*" or black cane is a thin cane of a dark purple colour. It has green leaves and yields but little juice: 24·25 per cent. of sugar by saccharometer; 15·19 per cent, of coarse brown sugar.

There is another variety of black cane with purple leaves which is used by the Burmans as a cure for insanity.

Mr. Bridges' enquiry is probably the most exhaustive that has been made into the varieties of canes.

The "Madras cane," introduced about 1860, is the most general in places where systematic cultivation is gone in for; otherwise Nos. 4 and 5 above.

6. *Recorded introduction of new varieties.*—There are no recorded experiments with exotic canes in Burma. As noted above, the "Madras" cane is generally distributed over the country. It is reported, however, that "Mauritius" cane grows luxuriantly and abundantly in Mr. Milne's grant at Zeyawadi, Toungoo. An experiment with Chinese cane in Kyaukse failed.

7. *"Sports" and seedling canes.*—No new canes are known to have been so produced in Burma.

8. *Other sources of sugar and spirits.*—No sugar is manufactured in Burma on any scale from any other source. The juice of the toddy palm is the favourite liquor of the drinking section of the community.

PART II.

CULTIVATION.

9. *Planting and reaping seasons.—In Lower Burma.*—Plant in September: also when 'ratooning' is in vogue from November to the beginning of January. Reap about November.

In Upper Burma.—Sown broadcast or planted in December and January and reaped in November to January.

10. *Rotations and mixed cropping.*—In Lower Burma the cultivation in the main sugarcane-growing tracts is generally permanent. Occasionally peas or other vegetables are taken as a catch crop in the cold weather. Generally only half a plantation is worked each year and a crop of paddy is frequently taken off the part not devoted to sugarcane.

Paddy and sugarcane thus practically rotate. In Upper Burma sugarcane rotates with early sesamum every alternate year, the period of fallow being three to four months in the year, *i.e.*, between the reaping and sowing of the respective crops.

11. *Ratoons.*—Mr. Bridges notes that when ratoons are sufficiently thick no new plants are put down after the cane has been cut, but as a rule cane tops are planted in the intervals between the ratoons

Fifteen years later the Settlement Officer saw only few instances of ratooning in the same tract and was told that the owner was letting his plants ratoon either because he was unable to procure more cane to plant or in order to obtain seed to plant the following year. The Settlement Officer notes that in Amherst they ratoon on an average for three years, occasionally for five years. Ratooning seems to be rare in Upper Burma.

12. *Preparation of the land for planting.*—The land is first cleared of all weeds and then ploughed up. The plough used is an iron one, and to make the furrows a wooden piece, in shape something like a bat, is fastened on to the blade. About a month or so after the cane is planted the ground is carefully weeded and the soil loosened. This may be done only once or it may be done three times during the year. It depends on the quality of the soil, the amount of weeds which spring up and the interest of the cultivator. Usually the weeds are removed and the ground loosened twice. In Upper Burma, for this crop, as for all other crops, the methods of cultivation are somewhat more thorough. The land is well ploughed and harrowed, trenches 6 feet apart and 1½ feet wide are then made by means of a plough and in the trenches holes, 12 inches deep, are dug with spaces of 6 inches between them. After the showers of April and May when the plants are about 4 feet high the trenches are filled up and three weeks after the ground between the rows is well hoed and loosened. In July and August small drains are made from end to end of the field to prevent flooding, and the earth thus obtained is used for banking and supporting the plants. Until the end of the rains weeding and repairing the banks are carried on. Only farmyard manure, and that sparingly, is used.

13. *Planting.*—After the land is furrowed the cane is cut into pieces about 1½ feet long, each piece having three or four eyes and is laid along the furrows with about 12 inches interval between each piece. This is done in September or October, sometimes a little later. A little earth is spread over

each piece. If cane tops are used instead of cane pieces, after weeding, holes are dug, each about 1 foot in depth and 1 foot across. Cane tops soaked in water to induce germination are then planted, generally three in a hole. The holes are then filled up, water poured on and the soil well pressed down.

14. *The source from which the seed is obtained.*—The Burman evinces a preference for cane pieces as against cane tops, his theory being that the out-turn of jaggery from a field planted with pieces is much larger than from one planted with tops. In flooded land when planting is late, tops are used for filling up intervals.

15. *The part of the cane used for planting.*—The general practice in Burma seems to be to cut up the whole cane into sets and plant them, only the lower rooting joints being rejected.

16. *The actual preparation of the sets for planting.*—There are generally three joints to each piece of cane used for planting. Canes which have flowered are never used for seed as they are considered worthless for planting purposes Occasionally cane tops are soaked a few days in water to induce germination, after which they are planted out. Nothing is done to resist fungoid attacks.

17. *The number of sets per acre.*—In Yamethin, where very careful enquiries were made by the Settlement Officer, the number of sets per acre is given at 11,150. The average for Lower Burma would seem to be just about 12,500 in the best land and 9,500 in second class land. There seems to be generally a certain amount of method in the planting.

18. *The mode of planting.*—The cane is ordinarily planted in trenches with intervals of a foot to a foot and a half between each cane and the cane is subsequently banked up. There is an interval of about 6 feet between trenches. These trenches are gradually banked up till they become ridges.

19. *Supplying vacancies.*—The Burman does not worry himself about failures and seldom, if ever, fills up vacancies I am not in a position to make any remarks on the keeping of canes.

20. *Seed beds and nurseries.*—I have not come across these in Burma.

21. *Stool-planting.*—No instances of this have come under my notice.

22. *Irrigation and drainage.*—In Lower Burma irregular irrigation from wells or streams is sometimes resorted to. In Kyaukse the land chosen is first well irrigated before planting. It is again irrigated 2½ months after planting if the land is at all dry; and again a month and three months later. If the field is at all water-logged a drain, 4 feet deep, is dug round it.

23. *Cultivation.*—Before planting the land is cleared of grass and weeds. About 10 days after the cane has been planted the earth is loosened in the intervals between the holes and the cane pieces further covered up with mould. In the beginning of January the earth is again loosened and the plants further covered up. About the month of May the land is again cleared of weeds and grass and the plants are then left until the month of August or September, when they are stripped of the leaves that have become old and withered. Clearing of weeds is done once or three times a year with the "Mamooty" or Burmese *dah*.

24. *Manuring.*—Is little used in Burma; the only manure available is badly treated farmyard manure which is occasionally used for sugarcane before planting. The trash is sometimes burned, but not universally. It is more generally used for fuel for the mills

25. *Treatment of the canes during growth.*—This is described in paragraph 23

26 *Treatment of the fields preparatory to reaping the canes.*—In Burma the fields receive no special treatment.

27 to 32. *Disease Phenomena.*—The disease which is most commonly known is red smut, while white-ants and the moth-borer are very common. In the total absence of scientific advice I am not in a position to note on the specific diseases referred to in these paragraphs.

33. *Reaping.*—The canes bloom about the month of November: they are then severed with a *dah* from the stool close to the ground. The tops and branches are cut off, the former being used for seed and the latter for cattle-food: the cane is then cut in two pieces of about 4 feet each and carried in bundles to the mill.

34. *Deterioration after cutting.*—The mill and furnace are always erected in the holding and close to the cultivators' hut: only sufficient cane to feed the mill for one day is cut: there is therefore no time for deterioration after cutting.

35. *Mode of cutting the canes.*—As close to the ground as possible; the tops extending to where the hard cane is met.

36. *Yield per acre in canes.*—Average number of canes in Mr. Bridges' enquiries 10,809—average weight 37,378 lbs. In Yamethin the average number of canes was 18,492; but the weight was not taken. In the area operated on by Mr. Bridges, the Settlement Officer in 1897 got the following results:—

Average number of canes per acre:—

Class I land	12,577
„ II land	9,503

Average weight of canes per acre (after tops cut off):—

Class I land	30,704 lbs.
„ II land	18,314 „

In Toungoo in Class I land the average number of canes was found to be 12,800 per acre and the weight 59,108 lbs.

PART III.

MANUFACTURE.

37. *Manufacture of jaggery or gur.*—The old form of mill described as follows by Mr. Bridges is still in very general use. "The mill consists of two heavy upright cylinders, about 1 foot in length and 2 feet in diameter. The cogs are circular and are cut in two rollers superposed to the crushing cylinders. A shaft about 12 feet long is fixed to one of the upper cylinders and is turned by a buffalo yoked to it. A few improved machines are now used: they consist of three upright pyingado cylinders and the middle cylinder to which the shaft is attached turns the other two by means of short straight wooden cogs."

Generally the older pattern mills still find favour; but in places they have been ousted by the newer pattern. Mills with only two cylinders but with the short straight cogs are also now in use. As all canes are pressed twice and sometimes thrice there is some saving of labour in having a three-cylinder machine, for as the cane is passed through from one side it is passed back again from the other. With only two cylinders one man has to be constantly gathering up the partly crushed cane and carrying it round again to the other side.

As the juice is expressed it flows into a bamboo frame beneath the mill and from thence through bamboo piping into an iron pan in the furnace room.

"The juice is carried in chatties from the receiving pan to the iron boiling pans which are placed there in a row over a furnance dug in the ground. The fire is kindled at one end of the furnace and boils all the pans in succession on its way to the chimney. The liquor is at first placed in the pan furthest from the fire, and as it evaporates it is passed on by means of ladles to the next pan, and from this to the pan immediately over the fire. It gets thicker as it passes along, and the impurities are removed by means of a wooden skimmer. In each pan is placed a bamboo frame-work to prevent the boiling juice from escaping over the sides of the pan. After the juice in the third pan has become sufficiently thick it is taken off the fire and passed into an iron pan, where it is allowed to cool for a few minutes. It is poured on a bamboo mat spread evenly with a piece of bone and then divided with a piece of pointed bamboo into small squares. After it has become hard it is broken into cakes and packed away into bamboo baskets covered with leaves. Each basket contains about 175 lbs. of jaggery."

Mr. Bridges introduced Thomson and Mylne's mills into Bilin. They were considered a great improvement on the wooden ones, but the cultivators objected to the small size of the cylinders: they would have hollow cylinders with a diameter of 1½ feet and a length of one foot, thus increasing the speed of the mill without any additional strain on the cattle. They would also have the shaft 10 instead of 7 or 8 feet long. As compared with the Burmese machine

in general use the Thomson and Mylne mill was 12 per cent. slower, but yielded 20·28 per cent. more juice and jaggery: as compared with the improved Burmese it was 25 per cent. slower, but yielded 7·40 per cent. more juice and jaggery.

Fuel.—The cultivators and their hired labourers bring in enough fuel from the jungle. The cane trash, after being dried for a day or two, is also used as fuel, not by itself but with wood.

Sugar-refining.—Several attempts have been made at sugar-refining, but the net profit on the work was so small that these attempts were not repeated.

Prices.—The prices fluctuate so much that it is hard to say what an average local price for jaggery is In Bilin the average opening price is nearly always R35 per 100 viss, but it goes down very quickly, as low perhaps as R16. A good deal of course depends upon the quality of the jaggery. The hard yellow cakes will keep longer and are worth about 10 per cent. more than the darker and softer cakes. The wholesale price in Rangoon is R35 per 100 viss in September and R30 in March, but the prices often fall much lower. The demand does not seem to be great, and is certainly not continuous, and a considerable amount of the jaggery, it is understood, comes from Madras.

38. *Profit and loss on sugarcane cultivation.*—The area under sugarcane cultivation in Burma is so small and scattered that it has in most cases not received special attention from Settlement Officers, but has been included amongst minor miscellaneous cultivation. Enquiries into profit and loss have however been made in Bilin, Amherst and Yamethin with the following results. Cultivators in Bilin always calculate by the *ta*—theoretically ·29 of an acre, but owing to local variations taken by the Settlement Officer at ·35 of an acre. The following is the cost of cultivation per *ta* :—

	£	ar.
Clearing, ploughing, cutting up cane and planting	2	0
First loosening and weeding	1	8
Second loosening and weeding	1	4
Seed cane	6	0
Tools (annual cost)	1	4
Total	12	0

This equals R31 per acre. Deducting half the cost of loosening and three-fourths the cost of clearing and ploughing for home work we get R26 per acre as the cost of cultivation.

An average outturn of jaggery may be taken at 700 viss per acre. The monthly wages for cost of manufacture (one boiling gives 6·5 viss of jaggery or about 1,370 viss per month) are—

	R
Two cutters at R11	22
Two buffaloes at R4	8
One herdsman	7
One cook	20
Total	57

Rupees 29 per acre, the average outturn being only 700 viss per acre.

Implements.—(Annual) :—

	R
One mill costs R40, lasts 5 years	8
Four cauldrons cost R5 each, last 4 years	5
Baskets, oil, etc.	9
Plough and furance repairs	10
Total	32

The average holding is 4·52 acres: cost of implements per acre R14. Cost of living is R75 per acre. The average price to meet the numerous fluctuations is taken at R22 per 100 viss Leaving the cost of living out of the amount we get 7 (00) × 22—(R26+29+14,=R154—R69=85 per acre, or deducting cost of living R75 per acre=Rs. 10 profit per acre.

In Amherst with a price of R30 per 100 viss, and excluding cost of living, the Settlement Officer got a net profit of R6 6.51 per acre. As the ordinary sugarcane cultivator has usually other land, it is difficult to equate the proportion of his cost of living which should be put down to sugarcane separately. With a proportionate reduction the profit would probably be about the same as in Bilin—R10 per acre, clear, after deducting cost of living.

In the Yamethin report the cost of cultivation varies from R75 to R97 per acre. On a valuation of canes at R1-8-0 per 100 with an average yield per acre of 10,000 we get R150—R75=Rs. 75 or R150—R97=R53 as profit per acre (without cost of living).

39 *Character and richness of the juice.*—In the absence of the chemical analysis (and I understand none has ever been made of Burma cane) I can only write in an amateurish manner on this paragraph.

The Settlement Officer in Bilin found the percentage of juice in the cane to be on an average 57·79 in first class land and 55·61 in second class, and the percentage of jaggery in the juice to be 16·81 and 16·18, respectively. These are the only statistics on the subject I can trace except the early investigation of Mr. Bridges. He found from 24·25 to 24·71 per cent of sugar to juice and from 14·45 to 15·76 per cent. of jaggery in the juice.

40. *Sugar-making.*—So far as I know this is not attempted in Burma; and the present small acreage under this crop hardly suggests that the Burma production will ever affect the commerce of the world. I hope to be able to bring samples from the Rangoon bazaar as suggested at the end of this paragraph.

The Chief Collector of Customs reports that the imports and exports of sugar are as follows for 1905:—

Statement showing the imports of sugar, refined, into the Province of Burma during the Calendar year 1905.

Country of shipment.	Country of origin	Quantity.	Value	Remarks.
		Cwts.	R	
FOREIGN TRADE.				
Sugar, refined.				
United Kingdom	Austria, Belgium, France, Germany, Holland, Peru, Java, Straits, Réunion, Demerara, Trinidad, Guatimala, British Guiana, and West Indies.	7,819	83,716	
Austria-Hungary	Austria	5,957	59,836	
Belgium	Belgium	597	7,512	
Germany	Germany	20,277	219,914	
Holland	Holland	492	4,432	
Egypt	West Indies	2	25	
Aden	Germany	5	31	
Ceylon	Germany	4	45	
Hongkong	Java and China	58,232	6,73,502	
Java	Java	204,828	2,118,466	
Siam	Straits	.	7	
Straits Settlements	Straits, Java and China	27,243	304,426	
Total		3,25,456	3,471,912	
Sugar, unrefined (excluding molasses).				
		1,970	18,715	Raw sugar.
Java	Java	358	3,221	Brown and unrefined sugar
Straits Settlements	Straits			
Total		2,328	21,936	

Statement showing the exports of sugar, refined and unrefined, into the Province of Burma during the Calender year 1905.

Country of shipment	Country of origin	Quantity	Value	Remarks.
COASTING TRADE				
Sugar, refined.		Cwts	₹	
Bengal	Indian	11,470	1,80,285	
	Foreign	965	14,606	
Bombay	Indian	40	795	
Madras	Indian	26,073	3,19,591	
Total		38,548	5,15,277	
Sugar, unrefined (including molasses)				
Bengal	Indian	11,809	63,136	
	Foreign	1,567	8,386	
Bombay	Indian	75	1,322	
Madras	Indian	3,882	37,771	
Total		17,333	1,10,615	
Grand Total		3,88,665	4,119,740	

Statement showing the exports of sugar, refined and unrefined, from the Province of Burma during the Calender year 1905.

Country of destination.	Country of origin.	Quantity.	Value.	Remarks.
FOREIGN TRADE.				
Sugar, refined.		Cwts.	₹	
Straits Settlements	Foreign	...	5	Re-export.
Sugar, unrefined (including molasses).				
Siam	Indian	457	1,820	Jaggery 455 cwts. ₹1,796.
Hongkong	Indian	1	10	
Madagascar	Indian	40	200	
Total		498	2,030	
COASTING TRADE				
Sugar, refined.				
Bengal	Indian	9	85	
	Foreign	562	6,886	
Bombay	Foreign	632	8,854	
Madras	Indian	1	15	
	Foreign	9	90	
Total		1,213	15,930	
Sugar, unrefined (including molasses.)				
Bengal	Indian	308	2 604	
Madras	Indian	30	232	Jaggery 19 cwts. ₹165.
Total		338	2,836	
Grand Total		2,049	20,801	

PART IV.

IMPLEMENTS.

41. The cultivation of sugarcane is on such a small, and apparently, a declining scale that the Department of Agriculture would hardly be justified in devoting much attention to it till some of the more popular and extensive crops have been exploited. The crop will however find a place on both the experimental farms; the indigenous variety will be carefully studied and exotics tried. We shall be glad to assist other provinces by trying under the peculiar conditions of Burma any experiments they may want attempted, *e.g.*, acclimatization experiments and the effect on Indian canes of transporting them to Burma.

MAYMYO: *The 8th December 1906.*

J. MACKENNA,
Director of Agriculture, Burma.

CENTRAL PROVINCES.

The chief districts in which sugarcane is grown in the Central Provinces can be divided into three classes according to the method of irrigation which is practised. In the districts of Betul and Chhindwara water is entirely supplied by wells. Further south in Chanda and Bhandara tank irrigation is the general practice, while in Balaghat and Bilaspur water is raised from low-lying *nalas* and tanks supplemented if necessary by wells. With this exception the methods of cultivation are fairly general all over the provinces. The cane-growing districts of Betul and Chhindwara lie on the Satpura plateau at an elevation of about 2,000 feet. Here in comparison with other parts of the provinces the climate is fairly cool and during the cold season the thermometer sometimes fall below freezing point, doing damage to sugarcane and other crops. The majority of the gardens in Balaghat have an elevation of about 1,000 feet and the climate is similar to that of Nagpur, but damper in the monsoon. Bhandara District is slightly cooler than Nagpur, the maximum temperature not usually rising above 112° while Chanda has recorded 119°, the highest shade temperature in the Central Provinces:—

Month.	NAGPUR, ELEVATION 1025 FEET.		RAIPUR, ELEVATION 170 FEET		CHANDA, ELEVATION 634 FEET.	
	Mean maximum.	Mean minimum	Mean maximum	Mean minimum	Mean maximum.	Mean minimum
January	83 5	54 9	78 5	54 1	85·1	53 7
February	84 2	54 3	79 1	54 0	86·1	52 9
March	93 5	66 4	91 9	67·1	97 1	66 5
April	101·0	71 1	97 3	71 9	100 6	72 4
May	110 8	82 3	106 5	81·9	109 4	83 2
June	106 5	81 9	105 2	83·5	106 4	82 4
July	88 6	75 3	80·3	73 8	90 9	76 6
August	88 0	75 3	86 0	75 8	89 1	76 2
September	86 8	73 1	86 7	74·6	87 1	73·6
October	91 5	66 4	89 1	69 3	90 5	66·0
November	87 3	60 0	85 3	60 5	87·1	56·7
December	82 8	52 4	70 5	58 3	82 6	48 3

Average rainfall during the last 38 years.

Month.	Nagpur.	Betul.	Chhindwara	Balaghat.	Bilaspur	Raipur	Bhandara	Chanda.
January	·10	54	76	·31	45	·33	·55	·27
February	·40	·21	·12	52	53	·42	·44	35
March	·33	·52	·40	·46	65	61	61	98
April	·38	·19	36	·86	85	51	·75	·53
May	·49	·40	53	·62	1 15	4 88	55	·64
June	8 90	7 80	8 60	11 14	8 52	10 87	9·87	7 88
July	13 11	13·45	10 90	18 58	14 16	11 07	15 36	10 22
August	10 01	11·75	7 59	15 02	11 99	13 30	14 15	12 95
September	8·15	7 21	9 05	9 89	8 11	6·91	9 51	9 08
October	2·06	2·13	1·84	1·73	1 93	1·91	1·10	1·84
November	45	·49	53	13	·52	·32	52	·48
December	31	·43	38	20	·24	·18	28	·25
	45·41	45 15	41·30	60·76	49·09	53 78	53·99	52 30

Area under cultivation.—Taken as a whole the area under sugarcane in the Central Provinces is decreasing. This decrease is most apparent in what were formerly the chief cane districts—Bhandara, Betul and Chhindwara. Its causes will be discussed later.

Table showing the decrease in area under sugarcane in the Central Provinces.

	Betul	Chhind-wara.	Balaghat	Bilaspur	Raipur.	Bhandara.	Chanda.	Provincial Area.		
								Irrigated	Non Irrigated.	Total.
	Acres.	Acres	Acres.	Acres	Acres.	Acres	Acres.	Acres	Acres	Acres.
At 30 years' Settlement—										
1864 to 1869 .	7,000	6,175	4,076	5,144	2,415	10,959	4,071		...	95,068
1894-95 . .	6,712	3 543	1,738	4,827	1,255	4,882	3,488	18,049	15,066	33,115
1899-1900 . .	16.6	2,946	1,120	2,851	625	3,020	2,313	23,448	1,757	25,205
1904-05 . .	2,789	1,529	1,543	2,799	795	2,186	1,026	19,001	1,788	21,389
1905-06 .	2,315	1,554	1,587	3,880	1,534	2,264	1,068	15,309	2,431	17,740

Character of the cultivation.—In the sugarcane districts almost every village has a few gardens which are generally small in area, about two acres being the average size. The position of the garden is changed from year to year, cane being grown once in the course of a three or four years' rotation. It thus most frequently happens that a new garden lies alongside the old one and is sown very conveniently as the crop on the preceding garden is harvested. The other crops in the rotation vary with the nature of the soil and water supply. On the lighter lands, such as the *sehar* of Balaghat, the rotation consists of rice, mung (*Phaseolus mungo*) or urad (*Phaseolus radiatus*) and sugarcane. On the black soil of Chhindwara and Betul the rotation is with wheat, gram, linseed, peas or mixtures of these crops. Gram has generally the reputation of being the best preparation for sugar. Various other rotations are occasionally practised. In Bilaspur sugar and urad are grown alternately; in parts of Chanda the land is left fallow for three or four years between the crops while in Chhindwara some ryots take sugarcane after cotton. This latter practice, however, is not at all a common one. Ground-nut (*Arachis hypogæa*), and sann hemp (*Crotalaria juncea*) are also sometimes grown as the preceding crop while upon the unirrigated areas of Bilaspur the rotation follows rice upon black cotton soils and til (*Sesamum Indicum*), urad, cotton or one of the smaller millets upon inferior land.

Soils.—Where the water-supply is good, much sugar is grown upon fairly sandy soils such as the *sehar* of Balaghat or *wardi* of Chanda. Of the black soils, *kali-morand* and *muttaharra* are all used, the majority of gardens being situated upon *morand*. *Kali* appears to be the least expensive land for sugarcane cultivation, the natural water-supply being good and less manure is required. Where, however, conditions are favourable *sehar* land produces good quality gur. The value of any land for sugarcane depends mainly upon its water-holding capacity.

Varieties of cane grown.—The varieties of sugarcane grown in these Provinces are few in number. The most important is *pachranga*, a purple and yellow striped cane found in pratically every district. It produces a fair quantity of juice and a good, although dark-coloured, *gur*. It is also fairly hard and so less liable to attack from jackals. This cane frequently gives a white sport known as *gadhara*, but the latter from the observation of the cultivators never throws back to *pachranga*. The origin of *pachranga* is quite unknown. It is frequently mixed in the gardens with a few stools of *kala*, a dark red cane having no particular value in the northern parts of the Provinces. To the south it is grown to a larger extent. A variety of importance in the north of the Provinces is a thick yellow cane known as *engrezi*, *poundhi* (Betul) or *bhoundhi* (Balaghat). It appears to have been an *otaheite* cane introduced about fifty years ago by Colonel Sleeman, then Commissioner of the Division. It is a cane yielding a large quantity of juice and a good quality, yellow gur. Its one disadvantage is that having such a soft rind it is much attacked by jakals and its introduction into some districts seems impossible unless all the cultivators adopt it simultaneously. Otherwise the jackals would select out the

poundhi gardens and destroy them completely. An attempt was made in 1904 to introduce this cane from Betul into Balaghat. It was only partially successful as owing to the time taken in transit many canes perished on the way. There is a fourth variety which is only grown in the Bilaspur and Balaghat Districts and which has proved upon analysis to be one of the richest canes in India. It is a greenish white cane smaller than *poundhi* and known as *malyagar*. There appears to be no record of this cane having been introduced into other districts, but as it grows only in the best parts of Bilaspur and Balaghat it is quite possible that it is less hardy than other varieties.

In addition there are a few varieties of hard canes which are frequently grown around the outsides of the gardens in order to protect the better varieties from jackals. Their juice is mostly used for drinking purposes, while the canes are given by the cultivator to his labourers and others.

Sugar is not prepared in these Provinces from any plant but the sugarcane. An attempt was made at the Nagpur Farm by Mr. (now Sir Bamplylde) Fuller to prepare it from *Sorghum*, but the product was unsatisfactory. The whole of the native spirit consumed in the Provinces is prepared from Mahua (*Bassia latifolia*).

General cultivation.—Throughout the greater part of the Provinces the cane is sown at the end of December or January and reaped at any time from the end of December to the beginning of March. It thus occupies the ground for at least 12 months, while in the Betul District the period extends to as much as 14 or 15 months. In some parts of the Balaghat District where an inferior variety of hard cane is largely grown, the crop is planted in March or April and reaped in November. In addition to the time the crop is actually on the ground another period of from two to seven months must be added during which the land is undergoing preliminary cultivation. When the poorer classes of cane are grown the rotation is frequently with one of the smaller millets or early paddy ; a mixture of kodon (*Paspalum scrobiculatum*) and kutki (*Panicum psilopodium*) is sometimes used for this purpose.

Mixed cropping is but little practised, chillies (*Capsicum frustescens*) and castor (*Ricemus communis*) with occasionally a little ambari (*Hibiscus cannabinus*) being the only crops grown with the cane. It is, however, a frequent practice to grow castor, tur (*Cajanus indicus*) or bhendi (*Hibiscus esculentus*) around the boundaries of the garden.

Ratoons.—The practice of ratooning is quite unknown in many Districts nor has it even been heard of. It is sometimes carried out for one year in the Bilaspur District on land where hard canes are grown without irrigation. In parts of Balaghat there is a superstition that if a cultivator continues to grow his crop from ratoons it will result in the gradual extermination of his family. At Dongaria, in the east of the Chhindwara District, *mung* or *sarari*, a thin hard variety, is sometimes grown from the stools of the previous crop after burning off the old leaves and watering, but the return is generally below that obtained from fresh seed. In the Betul District both the *poundi* and *pachranga* varieties have been tried from ratoons, but without success, the former in particular giving an unsatisfactory crop. This was, however, most probably due to the fact that no manuring was given the second year, but simply the usual amount of watering and interculture.

Preparation of the land.—This is commenced as soon as the previous crop has been removed, which gives, with a rabi crop occupying this position in the rotation, a period of seven or eight months before sowing. Following paddy the time for preparation of the land is much curtailed, but this is counteracted to some extent by the fact that such rotation is only practised on the lighter soils. Ploughing is done with a wooden country plough which consists of steepy inclined narrow share with an iron point but no mould-board. This is worked by two bullocks in two directions across the field and the soil broken into blocks without being inverted. About 10 to 12 ploughings are usually given or even more, with the result that a tilth to the depth of from 9 to 12 inches is obtained. If time permits one or two *bukharings* are also given and occasionally the land levelled by means of a heavy log of wood. The lumps of soil are then broken down by hand and except in paddy fields, water is given previous to planting.

In some districts a portion of the manure is usually applied at this time consisting generally of well decayed-cattle manure. Village refuse is also given if available. The practice of folding sheep or goats is unknown in the north of the Provinces, but sheep are folded in the Chanda District.

Source of seed.—All seed used is obtained locally, frequently from the adjoining garden or from a garden which has a local reputation for seed supply. The common practice is to uproot the whole cane, divide it into pieces containing three or four eyes each and use the latter as sets. Where *khari* land, *i.e.*, land receiving the village drainage, is planted with sugarcane, the crop is invariably sold for seed purposes. The reason for this is that cane from *khari* land never produces good *gur* and the canes being well grown, the practice of using them for seed is undoubtedly a good one. In districts where the harvest is early, canes for seed are left standing for a few weeks until required, while in others the seed cane is cut and planted before the main bulk of the crop is reaped. Occasionally the canes are topped as they stand and the tops carted away for seed. The rest of the cane is pulled for *gur* making when required.

Selection and preparation of seed.—There seems to be no preference amongst the ryots for any special part of the cane as seed, the whole being cut up and used indiscriminately. No observation seems to have been made or opinion formed as to which part of the cane gives the best outturn.

As a rule three eyes are contained in each set, but when the sets are sold the length of each is of more importance than the actual number of joints No preparation is given to the sets and, if necessary, they are left covered up with leaves for four or five days before planting. After that time they begin to lose vitality. In the few areas where inferior canes are grown without irrigation, the canes are soaked in water for eight or ten days before planting in order to hasten germination.

Planting.—This operation is always carried out in saturated soil except upon unirrigated land. In this case the canes are not cut but planted whole, an implement resembling a large country plough, called a *bawan*, being used. The *bawan* has a large hole passing downwards through the sole and through this the canes are passed and pressed into position as the implement is moved along. In general practice the land is divided by a plough with a double mould-board into furrows about two feet apart. At right angles to these furrows main water channels are formed, and as one coolie directs the water two or three others plant the sets. As each set is dropped into position it is pressed down by the foot to a depth of about five inches. As a rule the ends of the sets touch and even, in thick planting, overlap, the rate of planting being modified by the distance between the sets in the row rather than by the distance between the rows, which is fairly constant through all the cane-growing areas.

No other system of seeding is in vogue and should the germination be bad, nothing appears to be done to supply the vacancies.

Irrigation.—Within about a week of planting irrigation begins and continues regularly until the rains. Where the soil is light, water is applied as frequently as every fourth day. On black soils the period between waterings may be ten or even fifteen days, the time depending upon the depth and quality of the soil. Where water can be obtained from tanks the cost of irrigation is reasonable, but during recent years the expense of lifting it from wells has increased. This is alleged to be mainly due to the three following causes :— (*i*) Dearness of bullocks since the famine years, (*ii*) scarcity of water owing to a succession of dry years, (*iii*) dearness of leather *motes* due to the export of hides from the villages.

Should there be a *nala* near the garden a hole is dug in its bank and the water lifted by manual labour. The lift consists of a kerosine tin at one end of a pole and a lump of clay at the other, the pole being balanced at its centre. A man standing over the well pulls the empty tin down and when full the weight of the clay raises it again, the water being then discharged into a channel. In dry seasons the hole must be deepened, the rate of watering then becoming very slow. Where the source of supply is not more than four or five feet below the level of a garden an arrangement known as a swing bucket is used. With this two men sit over the water and by means of a shallow basket

held by ropes swing up small quantities into a distributing channel. From a depth of four feet about one-tenth of an acre can be irrigated in three days. After the rains have ceased, water is again applied at intervals of about three weeks, the applications becoming less frequent as the crop ripens.

Surface cultivation.—During the hot weather of April and May the land is worked with a *kudal*, a tool resembling a shorthandled pick. This if carried on continuously is one of the most costly operations, so that although weeding receives attention from almost all cultivators, thorough surface cultivation is only practised by the more wealthy. Nothing is done to the gardens after the rains until harvest except such application of water as is necessary. Mulching in any form is unknown, grass being in most districts very scarce. On an average about four or five weedings and one picking are given.

Manuring.—Only one form of manuring is generally practised, the chief exceptions being where the land receives village drainage or is folded by sheep. The bulk of the manure consists of sweepings and rubbish, mixed with a small quantity of cattle-dung. There is no general rule as to the time of its application. If the cultivator has a fair amount of manure for disposal then part is applied in the preliminary cultivation of the land and part subsequently as a top dressing. If only one application can be made it is generally done after seeding, during the hot weather. The ryots prefer the manure as well rotted as possible, otherwise it harbours white-ants. Artificial manures are absolutely unknown and seem likely to remain so while communication with large towns is so difficult and the majority of the cultivators lacking in capital. The supply of oilcake, although sometimes used as manure, is too small to be of much importance, many of the oil seeds grown in the Provinces yielding edible cakes suitable for cattle food. Much of the cane residue, after drying in the sun, is burnt under the evaporating pans, but as the prevailing form of furnace gives poor combustion with this fuel, the residue is frequently returned to the land where in course of time it decomposes. Green manuring is practised in the Betul and Chhindwara Districts only and even there to no great extent. Sann. Jagni (*Guizotia oblifera*) and occasionally urad are the crops used for this purpose, but the bulk of the cultivators have no knowledge of the practice at all. Ten to twenty-five cart-loads of manure are usually given per acre costing from Rs. 3 to Rs. 12. Where sheep are fed upon the land the cost may rise to Rs. 40 per acre for manuring.

Treatment of canes during growth.—It is the general practice in these Provinces to wrap the canes together in bundles of about six or seven and bind them with the lower leaves or with the leaves of inferior varieties growing on the outskirts of the garden. This operation is done twice during the months of July and August. Staking with bamboos is carried out in a few districts, but is not a general practice. The most important of these subsidiary operations is fencing as a protection against jackal and wild pig. This has become a great expense during recent years owing to increase in the price of wood. The fence generally consists of thickly matted thorny bushes sometimes supported between two rows of bamboos. It is frequently from four to five feet high and needs constant repair as the jackals force their way through wherever possible. Another plan in the Bilaspur District is to build a mud wall about five feet high around the garden, but this is quite a local practice. There is a great demand for gun licenses in many villages in order that a gun may be procured to scare away the animals at night when nearly all the damage is done. This, however, will not lessen their numbers appreciably and the continual firing can have only a temporary effect. A watchman is sometimes kept to guard the gardens, but the majority of the areas are too small to justify such an expenditure.

Treatment before reaping the canes.—In the best districts it is customary before harvesting the crop, and where a break in the irrigation has been made, to give two or three final waterings. Frequently, however, irrigation is continued regularly until harvest time and no reason seems to prevail for these practices.

Diseases and pests.—More canes are lost in the Central Provinces through wild animals, chiefly jackals, than through all other causes combined. Second to these pests is the troublesome parasitic weed Agia (*Striga lutea*). This is

most virulent during the rains and in the cold season dies off. Upon the lighter soils it is less noxious than upon the stiffer black soils, the *sehar* land of Balaghat being practically free while much loss occurs upon the *kali* and *morand* soils of Betul. Where gardens are badly infested the cultivators frequently rest them from sugarcane for some years and use *urad* and *jagni* as a green manure. Change of crop is also given, but even after ten years it is said to be difficult to effect a complete eradication. It is more than probable that the cultivators do not collect the weed and burn it at the most effective times. Attempts are made to get rid of the weed during the growing season, but it appears that when once a firm hold has been obtained it is frequently left to come to maturity and the part of the garden affected, more or less abandoned. The only other pests doing damage to any extent are white-ants and the moth borer. The former are mostly prevalent on the lighter soils and do not seriously interfere with the crop on *kali* or *morand* land. Moth-borer is fairly general and does considerable damage during the hot weather. Various methods are resorted to by the cultivators for ridding their gardens of these pests. A mixture of camphor and asafœtida tied in a bag is suspended in the water channel as a remedy for the borer. A piece of bear skin is used in the same way as a check against white ants. Incantations and offerings are made by the Gonds to disease-checking gods, this being also considered a remedy against damage by jackals. Salt dissolved in the irrigation water is used as a preventative for white-ants. Its utility, however, is questionable and it is perhaps worthy of notice that on *khari* land where the cane is supposed to be inferior through excess of salt in the soil, the damage caused by white-ants is not diminished. Apart from the cane actually devoured by jackals much loss is sustained by rot setting up where bruises have been caused by these animals.

Although as a rule the flowering of the cane causes no trouble to the cultivator, yet there are occasions when it is regarded as a grave misfortune. Such is the case in particular with the *Pachranga* variety which flowers only at very long intervals, but which phenomenon in some districts is regarded as a very ill-omen leading to the destruction of the cultivator's family. To prevent such a catastrophe the owner leaves his garden uncut when the crop becomes the public property of the village. Other minor forms of disease not widely prevalent in these Provinces are those which result in stunted growth. One of these called in the vernacular "*murri*" attacks the plant in March, causing the leaves to twist around the main shoot, while another form known as "*chihta*" acts in a similar way in July and covers the plant with a white netlike growth. Frost also does a certain amount of damage occasionally in the Betul and Chhindwara Districts. Amongst the cultivators white-ants are known as "*dimak*" and the moth-borer as "*ronthi*" or "*murer.*" Smut (Vern. *kanhi*) is but seldom seen.

Time and method of reaping.—The harvest for *gur* making commences as a rule about the end of December and continues until March. Where the ryots require money urgently the canes are frequently cut for eating purposes as early as November. Cane harvest takes precedence before all other work on the land and when once it has started and the weather is favourable it is carried on without a break until all is completed.

Should cloudy weather, however slight, intervene, harvesting and *gur* making are immediately suspended. As the earliest *gur* fetches the best price, harvest frequently takes place before the canes are really ready, although the advantage thus gained is, in the opinion of some cultivators, counterbalanced by the lower yield of juice. Canes which ripen very quickly are looked upon with disfavour by the ryots who prefer to see the tops remaining green for a considerable period

The milling and *gur* making plant is almost invariably situated quite close to the gardens so that no delay is caused in bringing canes to the mill. The gardens also being small, the cutting can easily be regulated to keep pace with the *gur* making, deterioration of the cut cane being thus prevented.

The canes are usually pulled up singly with a portion of the root attached and are then stripped and the root trimmed off by means of a small sickle, the work being generally done by women and children. The tops are also removed at the same time unless they have been taken previously for seed purposes.

Yield of canes per acre.—The following figures have been taken from a number of measurements made in various years and will give an idea as to the cropping power of an average sugarcane garden :—

Year.	Village.	District	Soil.	Variety of cane	Weight of cane per acre in lbs.	Weight of juice per acre in lbs.	Weight gur per acre in lbs	Mill used
1902-03	Koshi	Bhandara		Pachra ugan and Kala.	19,410	10,680	1,750	Poona.
	"	"		"	22,620	11,200	1,685	Local.
	Pathi	"		Dhaur (white).	42,170	24,700	5,020	Poona.
	"							
1904-05	Lanji	Balaghat	Silai	Dhauri	10,850	10,400	2,340	Poona.
	"	"	"	"	19,100	9,200	2,040	Local
	"	"	Mutburra	"	17,140	9,600	1,960	Poona
	"	"	"	"	17,180	8,000	1,740	Local.
	Aurna	Betul	Morund II	Engroza or Poundi.	15,450	8,000	1,550	Poona
	"	"	"	"	26,350	14,000	2,150	Local.
	Jowalkhera	"	Morund I and II, Kahor II.	Engroza, Pachranga, Sarradi.	30,800	16,000	3,150	Poona
	"	"	"	"	38,000	18,000	3,400	Local.
	Nuksi	Balaghat	Mutburra	Kathnaor Mangi.	7,590	3,200	590	Poona.
	"	"	"	"	7,460	3,000	575	Local.
1905-06	Lanji	"	Schar	Dhauri	29,200	17,300	3,300	Poona.
	"	"	"	"	24,100	11,960	2,620	Poona.
	Harda Tola.	"	Kachhar	"	33,910	21,070	3,330	Poona.

Manufacture of gur.—Only one method is in vogue throughout the provinces and this is of the simplest description. With the exception of the Betul District wooden mills are in most general use. They are made locally of babul (*acacia arabica*) and consist of two wooden rollers each with three skew teeth carved out upon the upper end. One roller is rotated by a bullock gear, the teeth conveying the motion to the other. Pressure is obtained by wedges which force the ends of the rollers inwards. A wooden mill can be driven by one pair of bullocks and will take from five to seven canes at once, but they need to be put through the mill three times before extraction is complete. Endeavours have been and are still being made to introduce iron mills into many districts, but these have not up to the present been adopted with much readiness. About twenty years ago the light iron Behar mill was demonstrated in the Betul District through the action of Mr. Macdougal, then Deputy Commissioner, and these met with so much favour that wooden mills in that district are unknown. It is only reasonable to suppose that had they been introduced into other districts at the same time their adoption would have been more general. At present the return from sugarcane cultivation is so uncertain that cultivators are unwilling to make a large outlay for a new implement although the cost of iron mills has greatly decreased. Twenty years ago the cost was Rs. 170; satisfactory mills can now be obtained for Rs. 40 to Rs. 80.

The mill is invariably sunk into the earth and the juice passes from it through a channel into a conical collecting jar sunk still deeper. To thoroughly cleanse the collecting jar is therefore a matter of some difficulty. The juice is strained as it leaves the mill through a piece of tin plate provided with holes, but this only removes the large pieces of foreign matter. When the evaporating pan is ready, the juice is baled into it, being strained as it passes through a wicker basket. This again is far from satisfactory and as the basket is well shaken when all the juice has been strained, very little real benefit results. The last of the juice passing through the basket is quite black in colour. The collecting pan is of such a size that it just holds enough for one evaporation. It is generally quite close to the furnace and only protected from impurities falling in by a bamboo mat. The pans, which are used singly, are about 7 feet in diameter and 12 inches deep. Formerly earthen pans were used and then iron ones, the ore being obtained from local mines such as those at Kinhi in Balaghat. At present the pans are either obtained ready made from Bombay or Calcutta or sheet iron is obtained and made up by the local smith. Occasionally such a man makes a reputation for his pans and then not only sells them over a large district, but may become an agent for iron mills as well. Efforts have been made to introduce the shallow form of pan from Poona, but without much success. One well-to-do cultivator, a malguzar, with a large area of cane, had been awarded one of these pans as a prize, but had not taken the trouble to fetch it quite a short distance by road.

The furnace is generally a hole in the earth bricked up to support the pan and with no other outlet, but the one where fuel is fed. A small outlet for the products of combustion is sometimes made at the back of the furnace, but no attempt is shown to prevent it becoming choked up. With such an arrangement combustion is very incomplete and the efficiency of the furnace very low. The fuel consists partially of leaves and residue of the canes, the latter having been previously dried in the sun. With the prevailing form of furnace the cane residue makes poor fuel and needs to be supplemented with wood. For this purpose the fencing of the gardens is used and larger material brought from the jungle. The provision of fuel, however, is one of the chief troubles of the cultivator.

As the scum rises to the surface it is strained off through wicker baskets the juice returning to the pan while the scum is not utilized any further. Neither liming nor any clearing process is practised although before the commencement of *gur* making the inside of the pan is rubbed with a mixture of butter, linseed and turmeric. The *gur* maker determines the point at which the evaporation is finished by the appearance of the bubbles of steam as they rise to the surface. The actual movement when the heating should cease is found by dipping the finger into water and then into the boiling syrup. If the latter congeals between the fingers and is of the desired consistency the pan is at once removed from the fire. After standing for about ten minutes it is poured into a flat rectangular box let into the earth to a depth of about 8 inches. When crystalised, the *gur* is scraped together into a cloth of drain; the resulting semi-spherical lump of dark yellow or brown material being known as a *bhela* and weighs about 140 lbs. Much of the *gur* made in the various districts is consumed locally and the remainder is exported chiefly to the Berars or the Hoshangabad valley. Here the superior quality of the Betul *gur* in particular still finds a market for it even against that produced at a cheaper rate in other Provinces Locally the *gur* is sold retail at about 5 or 6 seers per rupee, the price being a little higher, 4 to 5 seers per rupee, for best quality *gur* from the *Poundi* cane. It is also sold wholesale to merchants coming from outside districts at from 45 to 60 rupees per *khandi* (280 seers).

It is a point well worthy of notice that at every fair sized village imported crystalline sugar of good quality can be obtained at about 4 seers per rupee, a price but little higher than the locally manufactured and often inferior *gur*. The latter retains its market owing to its greater sweetening power.

Cost of the Cultivation.—The cost of cultivation of one acre of cane over the whole of the Central Provinces is on the average about Rs. 150. It becomes less when the cane is grown on larger areas, but comparatively few gardens are more than 2 or 3 acres in extent. Given below are detailed costs of cultivation obtained from village *patwaris* and cultivators. In some years

the crop yields a profitable return, but much depends upon fluctuating influences over which the ryots have no control.

The cost of cultivation of an acre of sugarcane in the Betul District (Jawalkhera village).

	Pachranga.			Engrezi.		
	Rs.	a.	p.	Rs	a.	p.
Cost of 24,000 sets	20	0	0	40	0	0
Charges for a *mote* and a *nara* for year	5	0	0	5	0	0
Wages of 2 men for 5 and 6 months respectively	40	0	0	50	0	0
Half cost of keeping a pair of bullocks	20	0	0	20	0	0
Sowing charges	2	0	0	2	0	0
Cost of 20 cart-loads of fencing materials	7	0	0	7	0	0
Charges for weeding 3 times	3	0	0	3	0	0
Charges for earthing once	2	0	0	2	0	0
Tying of leaves 3 times	6	0	0	6	0	0
Oil for mote and nara	2	0	0	2	0	0
Wages of 15 (men and women) for 4 days at Rs. 2-5-0 a day.	9	4	0	9	4	0
Cost of fuel	12	0	0	12	0	0
Hire for mill (Rs. 1-8-0) and pan (Re. 0-8-0) for 4 days	8	0	0	8	0	0
Rent on land	1	8	0	1	8	0
Cost of manure (cattle-dung and rubbish)	3	0	0	3	0	0
Hire for bullocks for juice expression for 4 days	8	0	0	8	0	0
Additional cost of watching for 3 months	...			6	0	0
TOTAL	148	12	0	184	12	0

Outturn per acre in a normal year—

Pachranga—5 khandis (1,400 seers) gur at Rs. 40 per *khandi*=Rs. 200.

Poundi or Engrezi—6½ *khandis* (1,750 *seers*) at Rs. 45 per *khandi*= Rs. 281-4-0.

Character of the juice.—The following table shows the composition and variation in the analysis of the juice obtained from cane grown in different districts during successive years. As the composition of the cane depends largely upon the nature of growth and time of cutting, these figures can only be taken as giving a general idea as to the value of the juice produced in these Provinces.

Composition of the juice and gur obtained from canes grown in the Central Provinces.

[Analyses made under the direction of Dr. J. W. Leather.]

Season.	Village	District.	Variety.	Per cent. by weight.		Per cent. by volume.		Gur	
				Cane sugar.	Glucose.	Cane sugar	Glucose.	Cane sugar.	Glucose
1903-04	Guriya	Chhindwara	Pachranga and Gadhera.	11·15	·820	11·87	·873		
	,,	,,	,,	12 60	·267	13 51	1 04		
	Nagalwara	,,	,,	8 18	1·52	8 67	1·72		
	Chikler	Betul	Pachranga	12 37	785	18 21	·785		
	,,	,,	,,	13·73	·851	14 77	·916		
	Betul	,,	,,	10 99	1·47	11·71	1 57		
	,,	,,	,,	12 84	·971	13 71	1 04		
1904-05	Auria	,,	Engrezi	12 16	1 72	13·20	1 83	66 30	13 09
	,,	,,	,,	14·09	1 77	15 07	1 89	66 10	14 94
	Jawalkhera	,,	Pachranga	13 20	1 15	14 11	1 22	74 97	9 65
	,,	,,	Engrezi	8 89	2 09	9·32	2 20	67·02	15 50
	Dunawa	,,	Pachranga	14 57	·748	15·55	·797	72 78	10 78
	,,	,,	,,	11 07	1 11	11 69	1·18	70 53	12 22
	Umri	Balaghat	Kathni	15 08	·653	16 19	·916	69 72	11 17
	Sawngi	,,	,,	14 71	·916	15 86	1·02	63·23	19·58
	Pangaon	,,	,,	13 12	1 10	14·31	1 17	73·06	10·54
	Langi	,,	Dhaurlor Malyagur.	20·52	·180	22 10	·197	79·42	8·65
	,,	,,	,,	17 53	·277	18·89	·299	81 34	6 75
1905-06	,,	,,	,,	18·30	·27	19 80	·29		
	,,	,,	,,	11·28	2 16	12 25	2 29		

Sugar-refining.—The preparation of any product but crude jaggery is absolutely unknown, although there is reason to believe that the introduction of simple methods for the preparation of more or less refined sugar would meet with a certain measure of success in the more advanced parts of the Provinces.

Import and Export trade.—The production of sugar in the Central Provinces is far from sufficient for the needs of the people and a very large import trade in both raw and refined sugars is carried on which has more than doubled itself during the last twenty years. The figures given below show the trade in maunds during the year 1900-05. Of the refined sugar imported during 1904-05, 78 per cent. came through the port of Bombay and 6 per cent. through Calcutta, the supply coming mainly from Mauritius.

The remainder, of Indian production, was imported in the year under notice from the United Provinces 10 per cent., Bombay 4 per cent. and Bengal 2 per cent. The unrefined sugar or *gur* came chiefly, during the same period, from Bengal 32 per cent., Bombay, excluding the seaport, 30 per cent. and the United Provinces 27 per cent. In comparison with the imports, the exports from these provinces are almost negligible, but during the year 1904-05, of the total *gur* exported, 80 per cent. was sent to Rajputana and Central India while quantities were also exported to the Province of Bombay, the Nizam's Territory and the United Provinces:—

	1900-1901.	1901-1902.	1902-1903.	1903-1904.	1904-1905.	1905-1906.
Imports—						
Refined .	349,765	4,38,311	391,609	512,617	529,011	674,588
Unrefined .	987,828	9,59,280	842,469	1,000,116	1,142,765	1,017,281
Total .	1,337,593	1,397,591	1,234,078	1,512,733	1,671,776	1,691,869
Exports—						
Total .	23,042	35,158	45,918	56,139	33,493	42,728

Causes of decreases in area under sugarcane.—Before considering the lines upon which improvement in the sugarcane cultivation of the Provinces is likely to be possible, it would be desirable to look into the reasons for the continual decrease in area which had been steadily going on. The causes can be divided into two classes—(*a*) increase in cost of cultivation, (*b*) substitution of other crops.

(*a*) *Increase in cost of cultivation.*—(1) The main factor for this increase given by the ryots in practically every district is dearness of the wood required for fuel and fencing. This also affects the cultivation in another way as fuel being dear, a great quantity of cattle-dung is burnt which cannot in these Provinces be replaced at present by any other form of manure. Figures are given comparing the cost of wood and the carting of same required for a garden of about one and a half acres at the present time with the expenditure necessary under former forest regulations:—

Expenditure incurred in former years to grow 30,000 sets, i.e., 1½ acres	R	a.	p.	Present expenditure incurred to grow 30,000 sets, i.e., 1½ acres.	R	a	p.
10 carts fencing in 15 days at 6 annas a day . . .	5	10	0	10 carts fencing in 20 days at 10 annas a day . . .	12	8	0
30 carts fuel in 30 days at 6 annas a day . . .	11	4	0	30 carts fuel in 45 days at 10 annas a day . . .	28	2	0
5 carts bamboos in 10 days at 6 annas a day . . .	3	12	0	5 carts bamboos in 10 days at 10 annas a day . .	6	4	0
1 cart wood for ploughs, etc, in 2 days at 6 annas a day . .	0	12	0	1 cart, wood for ploughs, etc., in 3 days at 10 annas a day	1	14	0

Expenditure incurred in former years to grow 30,000 sets, *i.e.*, 1½ acres.				Present expenditure incurred to grow 30,000 sets, *i.e.* 1½ acres.			
	R	*a.*	*p.*		*R*	*a.*	*p.*
				Charges for forest			
				10 carts fencing at 4 annas per cart	2	8	0
				30 carts fuel at 2 annas per cart	3	12	0
Forest charges	1	0	0	5 carts bamboos at 8 annas per cart of 100	2	8	0
				1 cart wood for plough	1	0	0
TOTAL	22	6	0	Total	58	8	0

(2) In recent years rainfall has been rather uncertain, and with the water levels in the wells low, the cost of irrigation has increased.

(3) Scarcity of cattle has affected the cost of tillage and irrigation while the exportation of hides has increased the annual outlay upon well gear. The cattle used by the ordinary ryot are frequently also of a very inferior type.

(4) Labour has in many districts become very scarce and the rate of pay has risen. A male labourer now received 3 annas a day and a female 2 annas, against 1½ and 1 anna respectively in former years. Many coolies have also gone to work in mines, while others owing to the boom in cotton have taken up land for themselves and grow that crop.

(*b*) *Substitution of other crops.*—The two crops which to a large extent have replaced sugar are cotton and wheat, these being, in the opinion of the ryots, less expensive to cultivate, and yield a more certain return. It is not unusual to see in some districts disused wells adjoining cotton fields and showing where sugar was formerly the most important crop grown. Certain tracts of land in recent years have also risen in importance as centres of wheat export, only sufficient cane to supply *gur* for home consumption being now grown.

IMPROVEMENTS.

(1) *Water-supply.*—With the extension of irrigation works and the cheapening of water-supply an impetus should be given to the sugarcane industry in some parts of the Provinces, although in many others cultivators must still depend upon their wells. Demands for mechanical power to replace bullock gear are occasionally met with, but owing to difficulty of transit and distance from skilled labour in case of a break-down, such an installation as even a simple wind motor would involve great expense.

(2) *Introduction of new varieties.*—Owing to the liability of the best varieties to be attacked by wild animals, introduction of improved canes must be accompanied by better protection from damage. The cane to be valuable must be hard and yield a large amount of juice of good quality. The best canes grown at present, from the point of view of *gur* making, are too soft. Indiscriminate introduction of new varieties must be carefully guarded against.

(3) *Manuring and cultivation.*—In practically all the sugarcane districts of the Provinces the introduction of artificial manures to any extent is at present out of question. Something might be done to advance the proper use of cattle dung, although this is difficult where fuel is scarce. The greatest promise seems to lie in green manuring and the selection of suitable rotations. One of the greatest sources of expense to the ryot is in the renewal of the fence around his garden each year and much would be saved if the cane could be grown in successive crops on the same land. Selection of varieties suitable for ratooning would assist in this and also mixed cropping to a certain extent. Something also might be done in the way of surface cultivation to conserve the water-supply in the soil and thereby lessen the amount of irrigation required, while considering the high cost of sets in proportion to that of the whole season's cultivation, it is not unlikely that a lower seed rate would yield a more profitable return.

(4) *Gur-making.*—Improvements in furnace construction are very necessary, particularly in the form of a grate upon which to burn a thin layer of fuel, and also an outlet chimney to give more draught through the furnace. Minor improvements in straining and clarifying the juice might also receive attention. The Poona form of furnace has been demonstrated in many districts, but has only been adopted in a very few instances. With *gur* commanding so high a price it is not easy to foresee the monetary return likely to be obtained by the manufacture of refined sugar. The molasses would certainly form a valuable addition to the present available cattle foods. Owing to the wide distribution of the sugarcane areas and the scarcity of irrigation, even small factories would be unworkable under present conditions.

APPENDIX.

Description of the varieties of sugar cane grown in the Central Provinces according to the method of Mr. J. W. Mollison and Dr. J. W. Leather—Agricultural Ledger No. 8 of 1898:—

Variety	Pounda or Engrezi.
Where grown	Betul, Chhindwara and Chanda.
General appearance	Fairly thick, tall and soft, yellow or greenish yellow in colour. Frequently bent at top. Black smudges common. Does not ratoon well.
Type	C.
Bloom	At nodes only.
Nodes—	
Ring N_1	Dark yellow but not very distinct.
Band N_2	Yellow dots in a green ring, root dots slightly marked.
Band N_3	Grey coloured.
Height	7 feet to 8 feet without tops
Girth	4 inches to 5 inches. Diameter increases towards the centre of cane.
Internodes	3¾ inches to 5 inches.
Aërial roots	On six or seven lower nodes only.
Buds	Very small, flat, oval, pointed, grooved, colour varies.

Variety	Pachranga.
Where grown	Fairly general throughout the provinces.
General appearance	A medium-sized fairly hard cane, irregularly streaked in purple, yellow and green. The cane is straight in growth and does not ratoon well.
Type	B and E, slightly zigzag.
Bloom	A little on the top internodes.
Nodes—	
Ring N_1	Indistinct, colour varies, generally light yelow. Extends around one half of the cane.
Band N_2	Root dots distinct.
Band N_3	Light grey in colour.
Height	6 feet to 7 feet without tops.
Girth	3 inches to 3½ inches. Diameter of centre part of cane slightly the greatest.
Internodes	2¾ inches to 5½ inches.
Aërial roots	On four or five lower nodes.
Buds	Khaki coloured, flat, oval, grooved, pointed.

Variety	Kala satla.
Where grown	In same districts as Pachranga and mixed with that variety.
General appearance	A dark purple cane, fairly long and straight. The rind is marked longitudinally by thin white irregular lines.
Type	B and E, slightly zigzag.
Bloom	On top internodes only.
Nodes—	
Ring N_1	Very distinct, light yellow.
Band N_2	Root dots smooth but distinct, on yellow ground.
Band N_3	Blue-grey in colour.
Height	7 feet without tops.
Girth	3 inches. Fairly uniform throughout length of cane.
Internodes	4½ inches to 5¾ inches.
Buds	Light brown in colour, oval, sharply pointed, grooved fairly prominent.
Aërial roots	At bottom node only.

Variety	Gadhara.
Where grown	In same districts as Pachranga.
General appearance	A medium sized cane, yellow or green in colour The nodes at the top and bottom are set fairly close together
Type	B and E, slightly zigzag.
Bloom	At nodes only.
Nodes—	
Ring N_1	Very distinct, dark orange in colour.
Band N_2	Greenish white with distinct root dots.
Band N_3	Grey ring, well defined.
Height	6 feet to 7 feet without tops.
Girth	3 inches to 3½ inches. Slightly thicker in middle part of cane.
Internodes	2½ inches to 5 inches.
Aërial roots	Up to the 10th node from the bottom.
Buds	Small, oval, brown in colour and grooved.

Variety	Bhondhya, Samdi, Kathai
Where grown	Balaghat, Bilaspur and Chanda.
General appearance	A dull brown coloured cane of nearly uniform thickness throughout its length The rind is marked by longitudinal thin black lines. Inside surface of leaves frequently pink at the base. A very hard cane.
Type	A generally, but occasionally B.
Bloom	Covers most of the internode.
Nodes—	
Ring N_1	Wide and distinct, light yellow in colour.
Band N_2	Root dots on a white ground, not distinct.
Band N_3	Grey ring, not well defined
Height	7 feet to 8 feet without tops.
Girth	2 inches to 2½ inches. Diameter fairly uniform.
Internodes	5½ inches. Very regular in length.
Aerials roots	On 3 or 4 lower nodes only.
Buds	Fairly large, pointed, oval, prominent, yellow in colour and not grooved.

Variety	Samdi.
Where grown	Chindwara and Betul.
General appearance	Dull purple, mixed with a little green in colour A thin cane and very hard.
Type	B
Bloom	Covers most of the internode.
Nodes—	
Ring N_1	A dark purple, swollen ring.
Band N_2	Irregular in shape with very prominent root dots on a pale yellow ring.
Band N_3	Light grey in colour, not well defined.
Height	5½ feet to 6 feet without tops.
Girth	1¾ inches to 2½ inches Diameter greatest at the bottom.
Internodes	2½ inches to 4½ inches
Aerial roots	On lower 2 or 3 nodes only.
Buds	Khaki-coloured scales with slight grooves, very small.

Variety	Malyagar or Dhouri
Where grown	Bilaspur and Balaghat.
General appearance	A medium-sized greenish-yellow cane with characteristic black smudges which extend downwards from the nodes rather more than half the length of the joint, rind soft.
Type	B.
Bloom	General, at and below nodes.

Nodes—	
Ring N_1	Distinct, pale yellow in colour.
Band N_2	Fairly wide, light yellow in colour, root dots numerous and distinct.
Band N_3	Distinct grey band of bloom.
Height	6 feet to 8 feet without tops.
Girth	3 inches to 4 inches. Fairly uniform throughout length.
Internodes	3 inches to 3½ inches.
Aerial roots	Very few and found on bottom nodes only.
Buds	Very prominent, oval, pointed and brown in colour deep grooves.

Eastern Bengal and Assam.

Preliminary.—The Agricultural Department was unable to spare an officer of its own for the enquiry into the sugarcane industry of the province. It had accordingly to be entrusted to District Officers, who collected information through the medium of their subordinate executive staff. The subject was an unfamiliar one to most of the investigating officers: much of the information received was therefore vague and unintelligible.

This Note has been prepared on the basis of the district reports, supplemented by such information as was available in the office of the Agricultural Department. The points raised in Mr. Barber's scheme of enquiry are dealt with *ad seriatim*.

Part I.

Introduction

2. Climate.—The climate of Eastern Bengal and Assam is fully described in the subjoined note written by Mr. G. T. Walker, F.R.S., Meteorological Officer to the Government of India:—

Temperature.—The mean annual temperature of Eastern Bengal and Assam is appreciably lower than that of other parts of India in the same subtropical latitude. This is mainly due to the cooling influence of the exceptionally heavy rainfall of the province in April, May and the first half of June, during which period the weather over the larger part of the rest of northern India is dry, and warmer than at any other time of the year. The strong contrast of temperature between the east and the west of northern India usually lasts until August, by which time monsoon rainfall should have fallen freely in the north-west, and its moderating affect on temperature is no longer confined to north-east India.

Monsoon rainfall ceases in Eastern Bengal and Assam at about the end of September, and from November until February there ensues a general similarity between the temperature of the province and that of the belt of country lying to the west of it in the same latitude.

Over the greater part of India the upper and lower limits of temperature occur in May and January respectively, and it is in May that the strong cooling influence of spring rainfall is most apparent in this province. Not only, then, does the rainfall of those months reduce the mean annual temperature, but it does so most conspicuously at the time when the warmest weather of the year would otherwise occur, and it thus very greatly diminishes the annual range of temperature, while deferring the actual maximum until July everywhere except in the coast districts.

The yearly range varies from 17° or 18° in the districts below the northern tropic to 23° in the extreme north-east corner of Assam, and when this is compared with the range of 30°, which occurs in the east of the United Provinces and Rajputana, it will be seen that the climate is unusually equable in this respect.

In the coolest months of the year, January, weather is warmer on the coast than in the interior, temperature varying from 60° at Dibrugarh in Assam to 67° at Chittagong; in July a nearly uniform temperature, differing little from 82°, is recorded over the whole province.

The following table exhibits the monthly average of mean daily temperature at twelve selected stations in the province:—

Station	Monthly average of mean daily temperature												
	January	February	March	April	May.	June	July.	August	September.	October	November.	December	Year
1	2	3	4	5	6	7	8	9	10	11	12	13	14
Chittagong	66 8	70 7	77 2	81 8	82 0	81 6	81·2	80 8	81 0	80 0	4 4	68 1	77·2
Silchar . . .	65 1	69 2	74 0	78 0	80·6	82·8	83 7	83 2	83 1	80 5	74 2	67 4	76 9
Barisal . .	66 0	70 7	76 8	83 8	84 7	83 6	83 0	82 5	83 4	81 1	78 0	68 9	78 3
Narayanganj .	66 0	70 1	76 1	83 8	83 6	83 7	83 8	83 3	83 7	81·6	74 8	67 7	78 5
Mymensingh . .	63 8	67 6	75 7	81 5	81 2	82 1	82 7	82 5	81 3	76 7	72 0	65 4	76 4
Bogra	64 6	67 4	77 1	84 1	83 5	83 5	83 8	83 4	83 0	80 0	72 2	65 5	77 3
Sibsagar . . .	59 8	63 2	69 6	74 3	78 8	82 0	84 0	83 6	82 2	77 8	69 0	61 1	73 9
Dhubri . . .	63 6	67 6	74 6	76 7	79 6	81 1	82 1	82 2	81 1	1 78 7	71 7	64 7	75 6
Jalpaiguri . . .	61 1	64 7	72 3	78 6	80 3	81 6	82 5	82 4	81 8	77 8	71 6	64 1	74·9
Dinajpur . . .	62 6	66 3	73 2	82 7	83 6	83 5	84 6	83 7	82 8	79 7	71 7	64 3	76 6
Tezpur . .	61 5	64 4	71 57	71 6	70 2	81 5	83 6	83 7	82 2	76 1	70 3	62 9	74 5
Dibrugarh . .	59 7	62 3	68 4	71 5	77 5	80 7	81 8	81 3	81 6	77 0	69 0	61 1	72 6

Humidity.—The high humidity of the whole province has become proverbial, and the results of observations bear out this popular belief, showing that, despite the great seasonal changes which occur elsewhere in this latitude as in other parts of India, the weather in the valley of Assam and delta of Bengal preserves its humid character with but small variation throughout the year. There are indeed few parts of the Indian area in which the air is so persistently damp as in Assam and the swampy regions of the Sundarbans at the mouths of the Ganges, without intermission from January to December; the upper half of the Brahmaputra Valley has a mean daily humidity exceeding 80 per cent, and over the remainder of the province humidity closely approaches that figure during the greater part of the year, while in February, March, April and November does it fall in mean value below 70 per cent.

The following table of mean relative humidity at 8 A.M., at twelve stations in the province for each month shows, how exceedingly damp the year is at all times of the year, and how near is the approach to saturation over the whole of the province:—

tation	Average relative humidity at 8 A M												
	January	February	March	April	May.	June	July	August	September.	October	November	December	Year
1	2	3	4	5	6	7	8	9	10	11	12	13	14
Chittagong .	87 8	81 3	82 7	80·2	82 4	86 2	89 0	85 7	85 4	89 6	88 0	80 5	86 5
Silchar .	91 0	87 0	82 1	82 7	85 3	89 3	90 2	90 9	90 7	89 3	87 0	81 9	89 0
Barisal . .	85 5	81 8	81 6	82 2	82 4	87 3	85 0	89 1	87 7	83 5	83 3	86 6	85
Narayanganj .	87 2	83 0	82 7	82 1	84 8	89 4	90 1	90 8	89 2	84 0	84 0	86 8	85 7
Mymensingh . .	91 4	84 0	81 1	82 0	83 2	89 6	90 6	90 8	91 3	85 3	88 7	91 2	87 9
Bogra . . .	85 2	79 4	73 0	76 5	82 1	87 5	88 8	88 8	88 8	83 5	83 3	85 3	83 9
Sibsagar . .	99 0	97 6	93 3	90 1	91 5	91 7	92 8	94 4	94 8	93 4	16 3	93 3	94 9
Dhubri . . .	91 1	83 7	74 5	75 8	83 0	90 6	90 0	90 6	91 6	88 6	87 0	93 8	87 1
Jalpaiguri . . .	90 0	85 5	76 0	75 8	83 5	89 3	91 8	91 7	90 7	88 1	84 2	88 5	86 3
Dinajpur . .	87 0	79 8	69 3	71·7	80 1	88 8	90 0	90 1	89 7	84 7	83 5	85 8	83 1
Tezpur . .	93 0	89 0	83 0	83 0	87 0	90 0	91 0	93 0	91 0	86 0	90 0	94 0	89 0
Dibrugarh . .	94 0	91 0	86 0	87 0	87 0	90 0	93 0	94 0	91 0	89 0	88 0	93 0	90 0

It cannot be said, however, that the absolute amount of water vapour present in the air is so marked a feature as is the humidity measured on the relative scale, that is, as a percentage of the possible or saturation amount. The quantity of vapour which the atmosphere is capable of containing depends solely on its temperature and increases rapidly with a rising thermometer; there are accordingly many parts of India and Burma where, in consequence of prevalent high temperature, absolute humidity is considerably above that of Assam, although the approach to saturation is not nearly so close. Such are the districts of Lower Burma and those lying along the Madras and Konkan coasts, where, from November to April, high temperatures and proximity to the sea give an absolute humidity greater even than that in the valley of the Brahmaputra.

Absolute humidity is near its minimum in the early days of the year and is subject to but slow increase during February; for the next four months however it rises rapidly more especially in the interior districts of Eastern Bengal and up to the extreme north-east corner of Assam. From May to September humidity remains steady, and thereafter very rapidly declines to a minimum near the end of December.

Cloud.—Skies are seldom entirely clear over the province at any time of the year, and although during the cold weather months, when clear weather prevails over nearly the whole of northern India, the proportion of cloud-covered sky is at a minimum, it is still in excess of 10 per cent. on the coast and of 50 per cent. at Sibsagar.

The cloudiest months are July and August when the proportion, which is fairly uniform over the whole province, lies between 72 per cent. and 93 per cent. The clearest months are November, December and January, but even then during the mornings thick fogs commonly cover the low grounds of Assam and the neighbouring tracts of Eastern Bengal, and remain undissipated till late in the day; these give place in the early spring, as the weather becomes warmer, to thick low-lying clouds, which gather daily over the valleys and afford the heavy rain which is a marked feature of the province at this time of the year.

Rainfall.—The rainfall of the province occurs in two periods of the year, the first extending from March to May and the second throughout the summer monsoon season.

The conditions which determine the earlier rainfall are largely those of geographical position and of the land surface, at any rate so far as concerns the two valleys of Assam, lying to the north and south of the uplands of the Garo and Khasi Hills. In the spring months there is no such continuity of steady rainfall as occurs during the monsoon, but the weather is characterised by storms which burst after the heat of the day, and generally come from a westerly or north-westerly direction.

The valley of the Brahmaputra is covered by swamp and forest land and largely protected by hills from the approach of drying winds; there is accordingly ample cause for its heavy spring rainfall in the excessive local evaporation. In the more open valley of the Surma and Barrak similar conditions also hold, with the added feature that the damp southerly winds from the head of the Bay of Bengal pass freely over its low-lying stretches and penetrate to the hills which form its northern boundary.

In Eastern Bengal the air during these months is on the whole less nearly saturated than in Assam, and rainfall, although it occurs there also, is less frequent and lighter than in the more easterly districts of the province.

Between these spring rain-storms and the succeeding rains of the monsoon season, a break of dry weather and westerly winds frequently intervenes.

During the months of the monsoon, rainfall is due as in other parts of north-east India, to the influx of southerly sea winds from the head of the Bay, and its distribution is necessarily much influenced by the contour of the country. The monsoon winds flow across the delta of Bengal in a direction nearly at right angles to the coast lines; where, their even flow being checked by the surface of the land, eddies and commotions result which induce heavy rainfall in the more immediate neighbourhood of the coast. These winds are hemmed in on the east by the Tippera hills and opposed on the north by the

Garo-Khasi range and the Himalayas. As a consequence they are deflected to the west and north-west, and while rising over the lower slopes of the hills undergo dynamic cooling which causes condensation of their water vapour and heavy rainfall.

For these two reasons the rainfall of the delta of Bengal decreases from the coast line on the south for some distance into the interior, and from the Valley of the Surma on the east to the broad plains of Bengal on the west. Thus the monsoon rainfall is found to decrease from 111·4″ at Sylhet to 62·3″ at Barisal, and to 50·3″ at Calcutta; while from Barisal to Dacca the gradation is from 62·3″ to 52·3″. Still further to the north the influence of the hills begins to display itself in producing a rapid increase of precipitation, so that the decreasing rainfall from Barisal to Dacca is succeeded from Dacca to Mymensingh, 70 miles nearer to the Garo Hills, by an increase of 18″. Rampur Boalia, which is at about the same distance as Dacca, but to the south-west of the Garo Hills, has a fall of 47·9″ in the five months from June to October; while Bogra 60 miles nearer, has a fall of 57·9″ and Rangpur, which is about the same distance as Bogra from the Garo Hills, but 70 miles nearer to the Himalayas, has as much as 68·0″ in the same period. In all these cases the greatest differences are shown in the earlier months of the monsoon, and the effect disappears in October, when proximity to the coast becomes the most influential factor in determining the distribution of rainfall. The same characters are shown also in the case of the more eastern stations of Noakhali, Comilla, Sylhet and Cherrapoonjee, where rainfall decreases from 92·9″ at the first station to 67·3″ at the second, and thereafter increasing, on the further approach towards the hills, to 111·4″ at Sylhet, culminates at Cherrapoonjee on the summit of the southern scarp of the Garo Range in the enormous fall of nearly 360″.

The following table gives the rainfall data for the spring, monsoon and winter months:—

Normal District rainfall.

Division	District.	Spring—March to May.	Monsoon—June to October.	Winter—November to February	Total of year.
		Inches.	Inches.	Inches.	Inches.
Rajshahi	Jalpaiguri	21·81	115·28	1·82	138·91
	Cooch Behar	21·63	96·96	1·10	119·69
	Rangpur	14·44	63·20	1·16	78·80
	Dinajpur	8·97	59·86	1·13	69·96
	Malda	6·23	49·02	1·63	56·88
	Rajshahi	8·66	46·88	1·63	57·17
	Pubna	12·12	47·26	2·08	61·46
	Bogra	11·33	52·98	2·00	66·31
Dacca	Mymensingh	17·43	67·13	2·02	86·63
	Dacca	16·81	51·49	2·83	71·13
	Faridpur	14·52	48·31	2·75	65·58
	Bakarganj	13·49	68·75	2·88	85·12
Chittagong	Tippera	18·09	55·00	2·50	75·59
	Noakhali	17·78	91·82	3·39	112·99
	Chittagong	17·43	91·47	2·91	111·81
Surma Valley and Hill Districts	Sylhet	39·97	94·45	3·46	137·88
	Cachar	38·42	86·64	4·54	129·60
Assam Valley	Goalpara	27·06	86·93	1·62	115·61
	Kamrup	21·68	53·39	1·86	76·93
	Darrang	21·86	58·37	2·71	83·44
	Nowgong	16·92	52·33	2·13	70·78
	Sibsagar	23·46	56·54	3·99	83·99
	Lakhimpur	30·38	77·71	5·53	113·62
	Manipur*	17·22	47·08	5·21	69·51

* Rainfall for one station only.

It will be seen that in the Assam Valley the rainfall is greatest at the two extremities, and smallest in the middle region represented by Tezpur, Gauhati and Nowgong: this peculiarity is possibly due to the fact that to the south of this region lies the most lofty part of the Shillong plateau, on the southern

face of which the monsoon currents are largely drained of their abundant water vapour before passing on their course over the central tableland to the valley beyond. To the west of the central plateau the valley is open to the winds of the Bengal delta, while to the east the average height of the hill range falls greately admitting the south-west monsoon by the gorge of the Jatinga Valley, over the low uplands of north Cachar and down the long valley of the Dhansiri, into the great plain of Sibsagar and Lakhimpur.

Notwithstanding the unusually heavy spring rainfall of the province of Eastern Bengal and Assam by far the greater part of the annual amount occurs between June and September, and has its maximum in June or July. Taking the period of the six months' heaviest rainfall, May to October, the rainfall of May at stations in Assam and the more north-eastern parts of Eastern Bengal varies from $\frac{1}{5}$ to $\frac{1}{10}$ of the total for the whole six months, and averages for all stations about $\frac{1}{7}$; whereas in the Gangetic delta it averages $\frac{1}{11}$, and decreases westwards until at some of the more westerly stations of the delta the proportion is only about $\frac{1}{15}$.

Storms.—The storms of Eastern Bengal and Assam are of three types, differing in both character and place of origin :—

(*a*) The cold weather storms which occur during the months of December, January, February and occasionally in March;

(*b*) The cyclonic storms which pass from the Bay of Bengal during the south-west monsoon period and

(*c*) The nor'westers and tornadoes, which are confined to the hot weather months.

The storms of the cold weather are similar in most respects to the depressions of Western Europe. They are caused by areas of low presure moving from west to east, exhibit a slight circulation of wind, and give rise to unsettled weather, with more or less precipitation. Many of these storms can be traced from an origin as far west as Persia, across the Punjab and the United Provinces to their final stages in Assam, where their presence is indicated by only a slight lowering of the barometer, cloudy weather and some rain.

The cyclonic storms which form in the Bay of Bengal move along paths which vary in direction from month to month, and cross the Coast of India at different points. As a rule these storms pass from the sea to the land to the west of the mouth of the Ganges, but from September to the end of December an occasional storm may move into the south of Eastern Bengal: none, however, has been known to penetrate up the Assam Valley beyond the Garo Hills. The most severe storms of this type occur in October and November, and it is in the former of these months that the province is most frequently affected by them.

The hot weather storms are perhaps of the greatest interest, for, while they are of smaller extent, they occur frequently, attain great intensity and are often very destructive. They appear to owe their origin to the inter action between the damp sea winds and the dry winds from the interior supplemented by the action of the hills in giving rise to vigorous forced ascents of air. Their usual form is that of severe thunderstorms accompanied by hail; but sometimes they develop into tornadoes, the most intense form of small revolving whirls. These are rarely more than a few hundred yards in diameter and their paths of destructive violence are seldom longer than 10 miles; but along these paths they advance rapidly and with little warning overturn and destroy houses and trees, and cause general destruction of life and property. The rainfall associated with hot weather storms is of importance in north-east India, and more especially in Assam, where it is a valuable factor in the growth of tea.

The great humidity of the atmosphere, the absence of hot parching winds and the abundant showers which are received in the three months preceding the advent of the monsoon give Eastern Bengal and Assam a decided advantage over most other parts of India in regard to the cultivation of sugarcane and many other crops. The need of irrigation which adds greatly to the cost of cultivation in other parts of India is seldom felt in Eastern Bengal and Assam. Herein the climate of the province approaches that of the cane growing countries in the tropics more closely than any other Indian province. Owing to the great rainfall during the monsoon and the constant humidity of the air, the

soil remains moist long after the cessation of the monsoon, enabling the sugarcane crop to continue in active growth for a longer period than in the drier parts of Northern India.

3. The age of sugarcane cultivation in India.—The Hindu scriptures abound in allusions to sugarcane. Many of these are quoted or alluded to in Dr. Watt's Economic Dictionary. The oldest reference is perhaps in the *Ramayana*, in which Rama is said to have worshipped the goddess Durga with an offering of sugarcane juice. The Sanskrit Dictionaries give numerous synonyms for sugarcane which it is hardly necessary to quote here. The District Engineer of Rangpur quotes a passage from the *Statak Smriti* in which the sugar-mill (*ikshu jantra*) is mentioned. He also quotes a verse from *Rajanirghanta* (of which the age is uncertain) in which mention is made of four varieties of sugarcane—(1) *Paundraka*, (2) *Banshekshu*, (3) *Syamekshu* and (4) *Raktekshu* which literally mean: (1) the sugarcane of Paundra, which signified in ancient times the country watered by the Karatoa river in Northern Bengal, included in the present districts of Rangpur, Dinajpur and Bogra; (2) the bamboo cane which is perhaps the same as the tall, thin, hard *khari* or *khagri* cane of the present time; (3) the yellow cane; and (4) the red cane, the last two being obviously the protoypes of the yellow or white and the red or purple canes of our times. In fact, were we to classify the canes grown at pesent merely from their outward appearance, we should have to adopt a similar classification to that of *Rajanirghanta*. It is possible that the name *Paundaraka* has descended to us in the shape of such words as *Paunda*, *Pura*, *Puri*, etc., all of which appertain to the thicker and softer varieties of cane suitable for chewing.

The extent and character of cultivation.—Sugarcane is cultivated more or less in every plains district of the province. There is very little of this crop in any of the hill districts. The only hill districts where an appreciable quantity of sugarcane is grown are the Chittagong Hill Tracts, Manipur and the Khasi Hills, but the area occupied by it is so small as to be almost negligible. The following statement shows the acreage under sugarcane in the year 1905-1906 in the several districts of the province:—

Division.	District.	Acreage.	Total.
Rajshahi	Jalpaiguri	4,700	
	Dinajpur	25,000	
	Malda	2,800	
	Rajshahi	18,100	
	Rangpur	16,000	
	Bogra	20,000	
	Pabna	3,200	
	Total	89,800	89,800
Dacca	Dacca	19,700	
	Faridpur	25,000	
	Bakarganj	18,500	
	Mymensingh	7,000	
	Total	70,200	70,200
Chittagong	Chittagong	9,000	
	Tippera	5,700	
	Noakhali	600	
	Chittagong Hill Tracts	300	
	Total	15,600	15,600
Surma Valley	Sylhet	22,000	
	Cachar	5,900*	
	Total	27,900	27,900
Assam Valley	Goalpara	1,200	
	Kamrup	4,300*	
	Darrang	2,200*	
	Nowgong	22,000*	
	Sibsagar	6,000*	
	Lakhimpur	5,000*	
	Total	20,900	20,900
Grand Total for the Province			224,400

The total area cropped with sugarcane in 1905-1906 thus appears to be about 2¼ lakhs or little short of a quarter million of acres. Out of this area about 90,000 acres, or 40 per cent., was in the Rajshahi Division, 70,000 acres, or 30 per cent., in the Dacca Division, and the remaining 30 per cent. was shared by the remaining three divisions It should be noted, however, that the acreages given above are, with the exception of those marked with asterisks, very rough estimates, which may be far from the truth. The acreages given against Cachar and the Assam Valley districts, with the exception of Goalpara, are based on survey and can be accepted as fully correct. Except for these few districts, it is not possible, from a consideration of the annual agricultural statistics, to say for certain what proportion of the total cultivated area is occupied by the sugarcane crop in each district, or whether the area has been increasing or decreasing in recent years. In the six districts for which accurate statistics based on a field-to-field survey are available, the actual areas under sugarcane in 1895-96 and 1905-1906 and the percentage which the area in the latter year bore on the total cultivated area are exhibited below :—

District.	Acreage, 1895-96.	Acreage, 1905-1906.	Increase+ or decrease— in 10 years per cent.	Percentage of area on total cultivated area.
Cachar . .	1,071	5,878	+440·8	1·9
Kamrup . .	3,810	4,315	+ 13·2	0·9
Darrang . .	1,951	2,177	+ 11·5	0·8
Nowgong . .	1,028	2,268	+ 16·0	1·1
Sibsagar . .	6,870	5,974	— 13·1	1·2
Lakhimpur . .	1,859	4,990	+168·4	1·9

The cultivation has rapidly increased in Cachar, where, as well as in the neighbouring district of Sylhet, time-expired tea-garden coolies have settled in large numbers and begun to cultivate sugarcane on hilly jungle-covered land which at one time was considered useless except for growing thatching grass. In the Lakhimpur district also, the area under sugarcane has undergone considerable expansion in recent years. The sugarcane industry in this district, as well as in the adjoining parts of Sibsagar and Darrang, is now mainly in the hands of Nepalese immigrants. These people are nomadic in their habits and scarcely remain in a place for more than five or six years. Their custom is to settle down in the midst of a forest, usually on the banks of a river, make a clearing in the forest, grow sugarcane on it for as long as a single crop with its ratoons will last, and then shift to a new forest site. They are able to produce jaggery so cheap that the native Assamese cultivators are unable to compete with them; hence in those parts of Assam where the Nepalese have taken to growing sugarcane, the natives of the country have practically abandoned its cultivation. To this fact may be attributed the slight decrease of area under sugarcane in the Sibsagar district, where of all districts in Assam the crop was at one time cultivated to the largest extent.

Though trustworthy statistics of area are not available for any of the Eastern Bengal districts or for Sylhet and Goalpara, it would appear from the district reports that in the open well-cultivated parts of the country, the cultivation of sugarcane is giving way to jute, which in recent years has assumed an unexpected importance owing to the extraordinarily high prices now being paid for the fibre and which is far easier to grow and gives a quicker return than sugarcane. On the other hand, the cultivation of sugarcane has been rapidly increasing in the more backward tracts where jute does not thrive well, *e.g.*, the hilly tracts in the south of the Surma Valley bordering on the Tippera Hills, and at the foot of the Sitakund Range in Chittagong, and *the high jungly tract of country in Rangpur known as the khiar or the barind.* There is no doubt that, barring jute in the more favoured parts of the country, there is no crop which pays the cultivator who can afford the labour to grow it so well as sugarcane, and the profitableness of the crop has rather increased than otherwise in consequence of the growing demand for jaggery, which has resulted from the opening up of communication in the interior of the country and the increasing prosperity of the rural population. The gradual introduction of iron-mills, which has enabled the cultivators to obtain larger yields of jaggery than was possible with the old fashioned wooden mills, is

another of those causes which have tended to make sugarcane cultivation more profitable than before.

Some of the district reports have assigned other more or less local causes for the increase or decrease of sugarcane cultivation. Thus, in Chittagong, it is said that the example of some planters, who have been growing sugarcane on hill slopes which were at one time considered worthless for any agricultural purpose, has led many people to do the same. In Goalpara, the subsidence of the ground level caused by the great earthquake of June 1897, is reported to have rendered the country excessively liable to flood and consequently less suitable for sugarcane thus causing a contraction of the area cultivated with that crop. A rise in the price of mustard cake, which is commonly used for manuring sugarcane in certain parts of Sylhet, is reported to have led to a curtailment of the sugarcane area in those localities. The inflow of saline water is, among other causes, held responsible for the comparative neglect in which sugarcane has fallen in the southern parts of the Backarganj district.

The cultivation of sugercane is of comparativly recent introduction in the Chittagong Hill Tracts, and possibly also in the Manipur State. In the Chittagong Hill Tracts, it was introduced from the adjacent district of Chittagong some fifty years ago. The cultivation of sugarcane in Manipur on a systematic scale is said to date from the time of Raja Sir Chandra Kirti Sing (1850-86), though the plant was not wholly unknown in the State before his time. The cultivation of sugarcane for *jaggery* is an industry of recent growth in the Noakhali district. A large area of sugarcane is found in the south-eastern parts of the Faridpur district, where it was unknown till 30 or 40 years ago. The crop is grown there on river *chars* or *dearas* which are annually submerged.

The bulk of the sugarcane crop in the province is grown in small patches of one or two bighas (one bigha=$\frac{1}{3}$ of an acre). The area of a sugarcane field is determined by the amount of labour at the command of the cultivator. There is a saying that a man who does not possess seven sons and twelve grandsons should not engage in sugarcane cultivation. Except in certain localities, it is rare for any one to grow sugarcane mainly or wholly with hired labour. The Nepalese sugarcane growers in Upper Assam, besides working with their own hands, employ a good deal of hired labour. A number of families squat down in one place and, sugarcane being practically the only crop which they grow and the only source of their income, the area cultivated by each is comparatively large. No information is, however, available as to the average area of sugarcane cultivated by each family. Two European planters, Mr. Cattell and Mr. Brownlow, and a Bengali planter, named Babu Nabin Chandra Sikdar, have large sugarcane farms in Chittagong, and an Assamese gentleman, Srijut Debeswar Gossain, cultivates about one hundred acres of sugarcane on his farm at Barpather, in the Sibsagar district. These farms are managed on commercial lines, and are believed to be profitable concerns. The land is cultivated wholly with the help of paid labour.

The principal kinds of soil on which sugarcane is grown in Eastern Bengal and Assam are either of deltaic or recent alluvial formation. The soil is either loam or clayey loam. Sugarcane is rarely grown on sandy soil.

Sugarcane is also grown to a considerable extent on a class of soil which passes under the name of old alluvium. It is believed to owe its origin to the disintegration of laterite rocks. It covers a large tract of country in the centre of the Rajshahi Division (known as the *Khiar* or *Barind*) and also occurs in many parts of the Assam Valley, notably in the Golaghat subdivision, which is an important centre of sugarcane cultivation. The same soil occurs in the tract of country in the Dacca district known as the Madhupur jungle. The soil is usually a red or yellow clay, having evidently a great deal of iron in its composition. The old alluvium tracts occupy a comparatively elevated level and are immune from floods. The soil is more difficult to cultivate than new alluvium (*pali*), and does not retain moisture so well as the latter. In such soil the planting of sugarcane has to be deferred till April or May (and often till June), or if the crop be planted earlier, it has to be nursed by frequent waterings through the early stage of its growth.

The only examples of sedentary soil in Eastern Bengal and Assam on which sugarcane is grown are met with in the low hills or *teelas* in Sylhet

and Cachar and the sloping plains at the foot of the Sitakund Range in Chittagong. The soil is derived from sandstone rocks and is usually of a light open texture.

Very few analyses exist of the soils of Eastern Bengal and Assam. A number of tea soils has been analysed by Dr. H. Mann and others, but these scarcely throw any light on the character of the soils on which sugarcane is habitually grown.

Generally speaking, the bulk of the area in which sugarcane is grown consists of land on which the ordinary crops of the country are grown. Such land is too poor to bear a sugarcane crop without being manured. In the Dacca Division and the southern parts of the Rajshahi Division a great deal of sugarcane is grown on land which is annually submerged, and, being enriched with silt, stands in no need of manuring. So also in the case of land newly reclaimed from forest, the soil is naturally rich in vegetable mould and is capable of bearing sugarcane without the help of any manure.

From what has been stated above, the various descriptions of land in which sugarcane is cultivated in the province will appear to fall into the following classes, on each of which the character of the cultivation is of a distinctive type:—

I. *Alluvial land beyond the reach of floods.*—It is the most important class of land on which sugarcane is grown in the open thickly-populated parts of the province. The soil is usually of a loamy character, and being seldom allowed to remain fallow, it is too poor, as a rule, to bear sugarcane without manure. The crop is, therefore, invariably manured and cultivated with greater care and attention than elsewhere. The varieties of sugarcane usually cultivated in this class of land are the medium soft yellow or white cane preferred for the manufacture of jaggery and also used for chewing.

II. *Alluvial land which is annually submerged and enriched with silt.*—This class of land is mostly found in the deltaic districts of the Dacca and Rajshahi Divisions. The land is never manured. The only varieties of cane that can be grown on such land are the thin hardy kinds of cane which can bear submersion. The crop receives comparatively little attention, and such operations as trashing and wrapping are practically unknown. The jaggery made is of inferior quality and in many places where the inundation is heavy and lasts long, the crop droops prematurely as the result of prolonged water-logging and has to be harvested as early as October.

III. *Old alluvium (khiar or barind) in the Rajshahi Division.*—The prevailing soil is a red or yellow clay which is more difficult to work than new alluvial soil and is liable to suffer from drought. Here, too, the thin hardy varieties of cane are grown by preference. They can stand drought better than the softer and more valuable canes, and receive less attention.

IV. *Land newly reclaimed from jungle.*—This class of land is found mostly in Upper Assam and in hilly tracts in the south of the Surma Valley and at the foot the Sitakundu Range in Chittagong. A nomadic system of cultivation is pursued. The land after being cropped with sugarcane is abandoned. The soil being rich in humus is never manured. In Upper Assam, the soil on such land is of alluvial origin and usually very rich. Successive crops of ratoon, often as many as five, are taken off the land before it is abandoned. The cultivation is of a primitive nature, though it is believed to be very profitable. The usual kind of cane grown on this class of land in Upper Assam is a thick soft white cane which elsewhere is grown only for chewing purposes. In the Surma Valley and Chittagong, the soil in newly reclaimed forest land is of sedentary origin, and is not, as a rule, rich enough to bear sugarcane longer than two or three years. The land lies high and dry, and the soil being of a light texture, the crop is liable to suffer from a prolonged absence of rain. There is, besides much risk of loss from wild pigs and jackals. For these reasons, the thin hardy varieties of cane, which are comparatively immune from drought and wild animals, are grown by preference in such land.

5. *Varieties of cane grown.*—It is not possible, from the meagre descriptions furnished in the district reports, to prepare anything better than a rough preliminary classification of the varieties of cane grown in the province. Appended to this note will be found a list of the varieties mentioned in the district reports with such description of each as has been furnished.

Roughly, the canes of Eastern Bengal and Assam may be divided (1) according to use, into (*a*) chewing, and (*b*) jaggery canes; (2) according to colour, into (*a*) white, grey, yellow or green canes and (*b*) black, purple or red canes; (3) according to character of rind, into (*a*) soft and (*b*) hard cane; and according to thickness of stem into (*a*) thick and (*b*) thin canes. Following this empirical clasification, the varieties of cane found in this province may be grouped as follows:—

I.—Chewing canes—tall, thick, and soft.

A. Black or purple.—It is known as Bombay or black Bombay cane in most district in Bengal, *Saheban* in Northern Bengal, and *Kalapura* or *Teli* in the Assam Valley. This variety was at one time largely cultivated, but it has proved extremely susceptible to disease (the red smut); nowadays it is grown in tiny patches near the rayat's homesteads and used only for chewing. It is a tall, thick, soft cane and is distinguished by the internodes being thicker in the middle than at the nodes. It is not, however, so rich in saccharine matter as some of the medium soft yellow kinds ordinarily grown for jaggery or the hard purple cane known as *Kajla*.

B. Yellow.—It resembles IA closely, except in regard to the colour of the rind which is of a yellowish green colour. It is variously known as *Pura*, *Bagapura*, *Bombay*, *Bom* or *Bompura* in different parts of the Assam Valley. This cane is grown largely by market gardeners in the vicinity of Dacca, and is known there as the White Bombay. It is the favourite cane of the Nepalese squatters in Upper Assam. It is subject to disease, but not to the same extent as the purple variety (IA). The *Verdamukhi* cane of Rangpur perhaps belongs to this class.

II.—Jaggery canes of medium size—fairly soft.

Yellow, white or green.—Includes the largest number of sub-varieties which cannot be distinguished from one another without a close study of their appearence and character in the field. In this class will come the *Mag*, *Mugi* and *Bagi* canes of Assam, the *Dhalsundar* of Dacca and the *Dhal* or *Dhali* cane of the Surma Valley. These canes are the most important among the varieties grown for jaggery. They are also largely used for chewing. The *Sharang* cane of Dacca and the *Shamsha* cane of Sylhet and Cachar belong apparently to this class.

III.—Reed canes—thin, tall, hard-rinded.

A. Yellow, white or green.—These canes rank as the hardiest of all. They are comparatively immune from injury by drought, innundation and wild animals, and are, therefore, grown exclusively in all situations where danger from these causes is feared. They also suffer less from insects and fungus disease. The commonest names for canes of this class are *Khari*, *Kheri*, *Khagra*, *Khagri*, *Ikuri Malaha*, *Magari*, *Majara*, etc., all of which are derived from the names of common reeds. These canes are poor in sugar-content, but as they grow freely and ratoon much better than any other, they seem to be coming into popular favour and to be supplanting the better kinds of cane in certain parts.

B. Black or purple.—Known variously as *Kajla*, *Kajli*, *Kali*, *Rangi Teliya*, etc., meaning either purple or black or of the colour of mustard oil. This variety ranks among the hardier canes, and next in this respect to III A.

IV.—Wild cane.

In *chur* lands in Eastern Bengal, a kind of reed known as *latá* or *khálá* is met with, which is used extensively as fodder. The canes are sometimes given to children for chewing. This reed is cultivated as a fodder in the *chúrs* of the Meghna and the Dhaleswari river in the Dacca district. The Collector of Faridpur has reported a variety of reed cane, which also is called *lata* and has furnished the following description of the cane:—

It is a yellow cane with a shade of purple, hard and not much thicker than a man's finger. In several places it is confused with he *khagri*, which is a distinct variety of recent introduction. It is too hard both for white ants and jackals and is generally grown on land that will grow no other cane, namely,

lands on which 4′ to 6′ of water stands during the rains. The *gur* is of bad quality and of blackish colour, and sometimes this cane is used as fooder.

But the Collector does not include it among the wild canes.

It is not quite understood what is meant by Giant canes. The Black Bombay cane (IA) attains an enormous size in good soil and under good cultivation, and may then be known as a Giant cane.

In regard to quality, the medium yellow varieties (*Mag, Dhalsundar, etc.*) are said to yield the best jaggery, and are grown in preference to all others wherever the surroundings are favourable to the cultivation of sugarcane. The *Kajla* cane is said to be the richest in sugar-content. The *Khari* or *Khagri* canes (IIIA) are the poorest in point of the yield of juice and sugar, but are preferred in many places for reasons already mentioned.

6. *Recorded introduction of new varieties.*—The Bombay varieties of cane are admittedly of foreign origin. The Black Bombay cane is believed to have been brought to India by Captain Sleeman from Mauritius. This cane is known as *Shaheban* (*lit.* brought by *sahebs*) in Northern Bengal and was introduced in Rangpur by some European planters in 1840 (see Mr. Glazier's Statistical Account of Rangpur, 1873). It was introduced into Assam either at the time of Captain Welsh's expedition (1793-94) or by European sugar-growers in Kamrup in the middle of the last century. Some of the district reports mention it as having been introduced some 50 years ago.

The *Sharang* cane of Dacca is believed to be identical with the *Samsara* cane of Bengal which is said to have been imported from Otaheite about the beginning of the last century. The Sylhet name of *Shamsa* might be only a variant of the word *Samsara*. These few constitute the only instances on record of exotic canes introduced in Eastern Bengal and Assam.

7. *"Sports" and seedling canes.*—Very few people in the province seem to know anything about "Sports" and seedling canes. Sylhet is the only district from which the phenomenon of "Sports" in sugarcane has been reported. The white *Khagrà* cane there is said occasionally to give rise to the red or *Rangi* cane.

An instance of a new variety which has come into existence as the result of degeneration is the *Assamese Pura* (also called *Keteki Pura*) cane of Assam which is believed to have sprung from an exotic variety (yellow *Pura*) of which mention has already been made.

Seedling canes are wholly unknown. Except in Upper Assam, it is unusual to see any "arrows" in a cane-field, and there it is only the tall reed canes that are found to flower. It is not known whether any one in Eastern Bengal and Assam has ever attempted to raise sugarcane from seed, nor is it known whether the seeds produced locally are fertile or not.

8. *Other sources of sugar and spirit.*—The only other source from which sugar is produced in Eastern Bengal and Assam is the date-palm which is largely grown in the western parts of the Faridpur district bordering on Central Bengal. Date sugar is also produced to a small extent in many other districts of Eastern Bengal, but the total quantity of date jaggery produced in the Province is after all small, and except in a few of the south-western districts, it does not affect the sugar market in any way. Date jaggery is preferred to cane jaggery on account of its nice flavour, but it does not keep well and turns sour during the rains.

Spirit is produced in Eastern Bengal and Assam from jaggery, *mahua* flowers which are imported from Behar and the United Provinces, and rice.

Part II.

Cultivation.

9. *Planting and reaping seasons.*—The season of planting sugarcane in Eastern Bengal and Assam extends from January to May. In moist alluvial soil, the planting takes place as a rule in the first three months of the year. Where the soil is liable to dry up during the hot weather, the planting is deferred till the spring showers in April and May have sufficiently moistened the soil, and in unfavourable years, the planting may be continued up to the first fortnight of June. In case of late planting like this, the invariable custom is to plant the sets in seed-beds, and transplant them later in the field. This

appears to be the common custom in most parts of the Assam Valley and in parts of the Dacca and Surma Valley Divisions. The market gardners of Dacca commence to plant their canes as early as November, but these are used only for chewing.

The reaping season for jaggery canes is governed largely by the exigencies of general agriculture. It does not commence usually before the close of the winter rice harvest about the middle of January. The reaping commences with the ratoon cane which attains maturity in a shorter time than plant cane, and where there is much of it, the crushing may commence as early as the middle of November, that is, as soon as the weather has become fair and settled. In the inundated tracts of the Gangetic delta where reed canes are grown, the harvest commences as early as September. The long water-logging to which the crop is subjected, causes it to droop prematurely, and the cultivators commence to gather it soon after the flood has subsided and left the ground high and dry.

The bulk of the cane crop is reaped between the middle of January and the end of March, but in localities where sugarcane is largely cultivated, reaping may continue to as late a period as the end of April. A Bengali saying,

Maghe una Falgune duna,

Chaite mule mul, Baisakhe nirmul,

embodies the wisdom of the raiyat in regard to the reaping season. Freely translated, it means that sugarcane reaped in *Magh* (15th January to 15th February) give slightly less (jaggery than the normal yield); if reaped in *Falgun* (15th February to 15th March), the yield is double; in *Chait* (15th March to 15th April), it just pays; but if reaped in *Baisakh* (15th April to 15th May), it ends in total loss. From this proverb, the best time for reaping cane in Bengal would appear to be the month from the middle of February to the middle of March. The weather at this time is moderately cool, and the cane after having reached its maximum growth about the beginning of December, has had time to complete those metabolic changes which result in the formation of sugar.

The cultivators know from external appearances, such as the drooping and withering of the leaves, the change in colour and glaze of the rind, etc., when the cane is ripe and fit for reaping; but they seldom look for any signs, and commence reaping as soon as the proper season has arrived and they are free to turn their attention to this work.

The period which elapses between planting and reaping may be said to vary from seven to twelve months. It depends chiefly upon the time of planting which, as stated before, extends from January to the end of May, varying according to the conditions of weather and soil, and upon the time when the cultivator is able to crush his cane. It would seem that the time of planting has little relation to the ripening of sugarcane. The crop, whatever be the time of planting continues in active growth all through the rainy season and during the first six weeks or two months of the dry weather which follows, and it is not until the growth of the plant has been arrested by the increasing dryness of the soil in January onwards that the ripening process comes into full play.

Very little is known in regard to the time which different varieties of cane take to ripen. In Dinajpur, the *Potashi, Saheban* and *khéri* canes are reported to be ready for crushing as early as October and November, while the *Moogi* and *Basna* varieties which appear to be those mostly cultivated do not attain maturity till March and April.

10. *Rotations and mixed cropping.*—Fixed rotations for sugarcane appear to be very seldom observed in any part of the province. In old cultivated land, sugarcane is preceded and followed by such ordinary dry crops as early rice, pulses, jute and mustard, and in the case of edible canes by vegetable crops

Mr. A. C. Sen, in his Report on the agriculture of the Dacca district, mentions an instance in which a regular system of rotation is followed. It relates to the cultivation of sugarcane by the market gardeners of Dacca, with whom cane cultivation is a speciality. They grow sugarcane for three years running (including two years for ratoon) on the same land. After this the

field is ploughed and sown with early rice or *mashkalai* (*Phasiolus Roxburghii*). It is followed again by sugarcane, which is again kept up for three years, and so on.

The practice of allowing land to remain waste for a number of years is a common one in many parts of the province It may be said to be the general rule in the poorer classes of soil, such as the red clay soil of the old alluvium tracts in North Bengal and Assam and the *teela* soil of the Surma Valley. The land is broken up and cropped with sugarcane for one or two years, and is then left waste for several years before it is taken up again for sugarcane. In Assam, a crop of *phaseolus* pulse is taken after sugarcane before the land is abandoned to waste.

Mixed cropping in case of sugarcane is not a common practice in Eastern Bengal. In Northern Bengal, *rahar* (pigeon pea) is occasionally sown in rows among the sugarcane. The Nepalese cultivators in Lakhimpur (Upper Assam) grow a little maize mixed with cane in the first year, the planting of cane as well as maize being done more or less broadcast. The market gardeners of Dacca cultivate melons along with sugarcane. The melon is sown in December and harvested in March and April, and occupies the interspaces between the rows of young sugarcane, with which it does not in any way interfere. In the Chittagong Hill Tracts, maize and *bhindi* (ladies' finger) are grown among sugarcane. These crops are off the ground before the cane grows high enough to overshadow them.

A common practice in many parts is to grow *rahar* on the edges of sugarcane fields. It serves as a wind-break, and also as a fence against cattle. Near Dacca, the stems of *rahar* plants thickly sown on the edges of the fields are tied together with horizontal pieces of split bamboo and made to serve as a fence against jackals and cattle. In Northern Bengal and Kamrup, it is common to see jute sown as a border round cane fields. Another plant called *bilakhani*, is occasionally sown on the embankments with which it is the practice in Assam to enclose sugarcane fields. It serves the same purpose as *rahar* and yields a large quantity of fuel for the boiling of jaggery.

11. *Ratoons.*—The practice of ratooning cane is general in the province. It is believed to be more profitable. In most places, the crop deteriorates so quickly that not more than one ratoon crop can be taken with profit. In exceptionally favoured soil, *e.g.*, the virgin forest soil of Upper Assam and Sylhet and the rich alluvial soil in the Chittagong Hill Tracts, as many as three to five ratoon crops are taken. The hard-rinded varieties of cane ratoon better than the softer kinds. One or two of the district reports speak of ratoon cane being more subject to red-smut than plant canes, but on this point very little information has been received. In innundated land the practice of ratooning is hardly possible and is rarely found.

12. *Preparation of the land for planting.*—The actual mode of preparing the land differs in three different kinds of land :—

(1) In the case of old cultivated land, which bears crops every year, the preparation of land does not commence till the commencement of the cold weather. Very often an early cold-weather crop, such as mustard, pulse or *til*, is taken off the land, and the cultivation for the sugarcane crop is not taken in hand till January. The land is ploughed up and harrowed with the ladder as many times as is found necessary to secure a good tilth. The number of ploughings varies naturally according to the character of the soil and the conditions of the weather, and has been variously estimated at from eight to twenty. The number of harrowings is about twice the number of ploughings given, the usual rule being to pass the ladder twice over the ground between two successive ploughings. The land is invariably manured with cattle dung except when it is enriched with silt. The manure is usually spread on the land either before the ploughings commence or in the intervals between the ploughings.

(2) In case of land that has remained fallow, the custom is to dig it up with the spade during the rains or in the beginning of the cold weather, and leave it in this condition for some time. Then after the clods have weathered down to some extent, the land is

ploughed and harrowed repeatedly until the requisite tilth has been obtained. Such land also requires to be manured.

(3) In case of virgin forest land, the first step towards preparation of the soil is to cut down the underwood and then after a time to fell down the overhanging trees. Fire is set to these heaps when sufficiently dry, and the ground is cleared as far as possible of partially burnt wood. These operations take place during the cold weather. The land is neither dug nor ploughed. All that is done is to dig out the pits in which the sets are to be planted. The pits are dug some time before the planting takes place in order to aerate the soil. No manure is used. The soil being rich in vegetable mould needs none beyond the ashes derived from the burning of the forest.

The use of the crowbar for cultivation is unknown in Eastern Bengal and Assam. The only implements used in the tillage of sugarcane land are the spade (*kodali*), the plough and the ladder (*mai*). In clayey soil, it often becomes necessary to use a wooden mallet for crushing the clods which cannot be reduced by the ladder.

Bare fallowing in the sense that the land after being broken up is left uncropped for a year is not known to be practised in any part of the province.

13. *Planting.*—The various points under this head will be considered in paragraphs 14 to 21.

14. *The source from which the seed is obtained.*—The cultivators purchase the seed only when they first start cultivating the crop and rarely afterwards. They preserve the "tops" of their own crop and use these for seed. The only instances in which cuttings are procured annually from a distance have been reported from Faridpur and Bakarganj. In the inundated parts of those districts, the cane crop is harvested as early as September and October, and the crop dies prematurely as the result of prolonged water-logging. Hence the necessity of obtaining cuttings from a locality where the crop is free from injury by floods. In the neighbourhood of Dacca City, the market gardeners occasionally purchase sprouted cane cuttings which are sold at R5 per thousand.

The "tops" are taken from plant as well as ratoon cane. The latter is preferred in some localities owing to the internodes being shorter. In Upper Assam, "tops" from ratoon canes are considered worthless and hence seldom used.

The practice of leaving a portion of the cane crop to stand over till it is required for use as seed cannot be said to be a general one in Eastern Bengal and Assam. It is possible only in those places where the sets are obtained by cutting of the whole cane into pieces. It is known in Manipur, in the Jabarmal mauzas of Bakarganj which supply seed for the inundated tracts in that district and Faridpur, and in the country round Dacca. In Rangpur, entire fields of ratoon cane are sometimes bought up for seed purposes and these also may be regarded as "stand-overs."

15. *The part of the cane used for planting.*—The general practice, as already mentioned, is to use the upper part of the cane, that is to say, the "tops" for seed; but there are localities in which the whole cane is cut up into sets for seed. The latter practice has been reported from Rangpur, Backarganj, Sylhet, Manipur and the country round Dacca, but it is after all only secondary to the use of "tops" which are always preferred.

In using sections of the whole cane for seed, the lower rooting joints are always excluded Sets obtained from the whole canes often fail to germinate, hence it is never safe to use them except where the sets are first planted in a nursery and only such as produce shoots are transplanted in the field.

The use of the whole cane as seed is reported to be practised in some villages near Kutubpur in the Rangpur district. The practice does not seem to be known elsewhere.

16. *The actual preparation of the sets for planting.*—In most places the "tops" which contain six or more joints are cut up into sets, each containing two or three internodes. In Rangpur, the tops used are about a cubit long and are not cut up into smaller pieces as is done elsewhere; but sets obtained from the whole cane contain three or four internodes each. In the Assam Valley

the general practice is to keep three or four joints in each set, and often so many as six to eight. In Sylhet and Chittagong a set often contains a single "eye" the practice being to plant the sets in the first instance in a seed bed to ensure germination.

Pickling the sets in various solutions before planting is a practice which may be said to be practically unknown in this province. In Rangpur the sets are sometimes pickled with kerosine oil and water as a preventive against white-ants. The soaking of sets in water before planting is a common practice in many parts of the Province, the object aimed at being to accelerate the germination. It is also said to reduce the sweetness of the sets and thus to render them less attractive to white-ants.

17. *The number of sets per acre.*—The number of sets used per acre has been variously returned at from 3,000 to 4,000 in Lakhimpur to 30,000 in Rajshahi. It depends, of course, on the distance at which the sets are planted from each other. The larger figures (15,000 and upwards) are reported from districts or localities in which the harder and poorer varieties of cane are grown. These are planted close and receive less attention than usual.

18. *The mode of planting.*—The mode of planting varies in different localities, and depends on the character of the cultivation pursued. A few typical examples are quoted below.

In virgin forest land in Upper Assam.—As already mentioned, the forest is cut down and burnt, and the land is neither ploughed nor hoed, and no manure is used. Pits are dug in the ground and into these the cuttings are placed. Reaping and planting usually proceed about the same time, and the sets are planted out straight off without receiving any preliminary preparation. No fixed distance is observed in digging the pits, but they are made equidistant as far as the nature of the ground, encumbered as it is with stumps of trees and partially burnt wood, allows. The pits are made about one yard from each other, so that about 4,000 cuttings suffice to cover an acre. The depth of the pits is about 12 inches.

In old arable land in the Assam Valley.—The soil is prepared by repeated ploughings and harrowings, preceded, in the case of fallow land, by digging with the spade. The planting takes place in April and May. The day chosen for planting must be preceded by sufficient rain, and if drizzling rain lasts throughout the day, so much the better. The field is partitioned into strips of 8 to 12 feet in width separated by drains, which communicate with a ditch which surrounds the field. Trenches 2 to 3 feet apart are made with the spade; these run at right angles to the drains, and in these trenches the sets are planted, about 9 inches apart from each other. A little soil, often mixed with cowdung, is lightly scattered over the cuttings and they are left to themselves until they strike root.

In old alluvial land in Rangpur.—The land is prepared by ploughings and harrowings as elsewhere. Furrows are made with the plough 12 inches apart, and along these the sets are laid down 4 or 5 inches from each other. The furrows are fairly straight and equidistant and about 6 inches deep. After planting the sets, they are covered over with soil taken from the sides of the furrows so as to make the surface level.

In the flooded tracts of the Gangetic delta.—After the land has been prepared by ploughing and harrowing, shallow trenches, about 2 inches deep and 12 inches apart, are made with the spade, the "tops" are laid in the trenches at intervals varying from 12 to 18 inches and buried 2 inches deep after which the trenches are filled up with earth. The sets thus lie about four inches below the ground.

Near Dacca for chewing canes.—Ploughing and harrowing is commenced about the middle of September, and the land is got ready by the end of October. Parallel lines are drawn all over the field, 36 inches apart, and along these lines, at intervals of about 12 inches, pits 6 inches to 9 inches deep are dug with the spade, about 12 inches square on the surface and with slanting sides. The bottom of the pits is stirred with the *kodali*, and the earth below is mixed with a little soil from the top and some well-rotted cowdung. While the field is being prepared, the sets are "hatched" in a nursery, and the young plants become fit for transplantation when they are about a foot high. In each pit are placed two cuttings with the shoots on, and the pits are then

partially filled with soil, which is pressed round the plants. The plants are watered daily from a pot until they strike root.

In Manipur.—The field is laid out into beds, 8 feet wide, separated by furrows which serve as drainage channels. Three parallel rows of pits are dug on the ridges, the rows being 2 feet apart from each other and the pits about 8 inches from each other along the rows and 4 or 5 inches deep. Well-rotted cowdung and ashes are placed at the bottom of the pits The planting takes place in April and May. The sets are previously planted in a seed bed, and throw out shoots, when they are taken out for planting in the pits. Four sets are planted together in each pit, of which one set is from the stem of the cane and three from the "tops." The sets are carefully covered with soil, and are watered immediately after planting and thereafter daily for some days. A mulch of grass is spread over the land to conserve moisture.

19. *Supplying vacancies.*—Careful cultivators preserve sets for filling up vacancies, but in most places vacancies, unless too many, are left unsupplied. Vacancies seldom occur when sprouted sets are used. In Rangpur, the cultivators occasionally fill up vacancies from sets thickly planted on purpose in the outskirts of the field. In Dinajpur, large vacancies, when they occur, are sown with jute.

When vacancies are filled up with fresh sets, it is done, as a rule, at the time of the first hoeing and weeding, which takes place within a fortnight to a month from the time of planting.

Cuttings are preserved in various ways. If they are to be planted within a fortnight or at the longest a month, after the cane has been reaped, they are kept in a cool, moist place protected from the sun. In some places the cuttings are planted thickly in a slanting position and covered with rice-straw, plantain leaves or loose earth, over which water is sprinkled from time to time. In other places they are tied together into bundles with the bottom ends on one side and embedded half-way up in soft mud

If the cuttings are to be preserved longer than a month, they are planted in a seedbed or nursery in the manner described in the following paragraph:—

20. *Seed-bed and nursery.*—The practice of planting the sets in a nursery and making them sprout and throw out shoots before transferring them to the field is in vogue in most parts of the Province. In Northern Bengal alone it seems to be unknown. The *raison d'être* of the practice is to be found in the fact that irrigation is all but unknown in the Province, and except where the rainfall is assured or the soil is naturally moist, there is always some risk in planting the cane in the dry season. The planting of the crop has, therefore, to be deferred in many places until sufficient rain has been received in April and May and the risk of loss from drought has passed away. The nursery is made in a cool moist spot in the raiyat's homestead or near a well or tank. The ground is carefully prepared and liberally manured with cowdung and ashes. The soil is heavily watered and converted into puddle. The cuttings are laid horizontally and half buried in the mud, so as to leave only the upper surface visible, and so placed that the eyes or buds remain level with the ground. They are placed so thickly as to almost touch each other. The seed-bed is kept wet by watering from time to time.

Near Dacca, where young cane plants are raised for sale, great attention is paid to the cultivation of the seed-bed. After the cuttings are laid in the puddled seed-bed, powdered earth mixed up with ashes is spread over the bed, about 1½ inches thick, and over it is placed a mulch of rice-straw. After a day or two, when the seed-bed is found sufficiently dry, the straw is removed and the surface soil is gently stirred and pulverized, after which the straw is again put back over the seed-bed. Within a fortnight the cuttings begin to sprout, and within another fortnight or three weeks the shoots will have grown to a foot or eighteen inches high and become ready for removal to the field.

21. *Stool-planting.*—The practice of propagating cane from stools is known only in parts of the Sylhet and Nowgong districts, and even there it is rarely found.

22. *Irrigation and drainage.*—It is a most unusual thing to irrigate cane fields in Eastern Bengal and Assam. The crop is occasionally watered from pots for a few days after planting, and that is the only irrigation which it ever receives.

The market gardeners of Dacca, however, occasionally irrigate their cane fields from *kutcha* wells. The soil of the country near Dacca is a red ferruginous clay of lateritic origin which is apt to suffer from drought during the dry season. The same soil is found all over the Madhupur jungle in Dacca and in the *khiar* or *barind* tract of country on the opposite bank of the Bramaputra in Northern Bengal. The softer and more valuable kinds of sugarcane cannot be grown on such soil without irrigation.

The raiyats are careful in the matter of drainage. In all situations which permit of the water being drained off the field, the land is enclosed with a ditch partitioned into compartments by parallel drains or furrows communicating with the outer ditch. In flooded tracts drainage is of course out of the question.

23. *Cultivation after planting.*—The after cultivation of the crop consists in weeding, hoeing and earthing up the roots of the cane. The number of hoeings and weedings considered necessary in different places and the implements used are mentioned below :—

Rangpur.—Two weedings with the hand-hoe (*pasun* or *khurpi*) and two ploughings between the rows with the country plough.

Rajshahi sadr.—One hoeing and weeding with the spade, followed a month later by one inter-ploughing between the rows.

Dinajpur.—In May, the weeds are uprooted by hand, and the interspaces between the rows are ploughed with the country plough. The same is done again in July.

Dacca chewing canes.—The cane is planted early in the cold weather. When the plants have taken root, the field is weeded and the soil near the roots loosened with the hand-hoe (*pashuni*). A few days after, the whole of the interspaces between the plants is hoed up with the spade, and the pits in which the cane was planted are partially filled A second hoeing with the *pashuni* is given a fortnight later, and this time some well-rotted cowdung is placed round each clump and the pits filled up with earth. Another weeding and earthing follow, in the course of which the plants are earthed up. Throughout the rains, the field is kept clean and the soil loose by weeding and hoeing at intervals.

Faridpur.—After the plants have germinated and taken root, the field is weeded and the soil round the plants loosened with the sickle (*kachi*). Hoeing with the *kodali* follows, and when the plants are a cubit high, they are earthed up in V-shaped ridges. A second and occasionally a third weeding and hoeing are given.

Bakarganj.—Three or four times with the spade.

Chittagong.—Two hoeings with the spade. Additional weeding is not considered necessary except in the upland farms where the thatching grass comes up with the canes and has to be removed.

Tippera.—Two weeks after germination the first hoeing is given. It is repeated after every shower. Five to seven hoeings are considered necessary. When the stumps have grown about 8 feet, earth is thrown up round the roots so that the plants stand in ridges with furrows between the lines.

Chittagong Hill Tracts.—Three times during young growth.

Assam Valley.—In old cultivated land, the surface soil is hoed and the weeds removed with the *khanti* (spade) three or four times, and the cane is earthed up when three feet high.

Upper Assam.—In new forest land, three weedings and hoeings are considered sufficient. In the first year, this is done with the *dao*, and in ratoons the *kodali* is used. Only the surface is scratched to break up the hard soil. Mulching the field with grass after the cane has been planted and before it has had time to cover the ground is not in vogue.

24. *Manuring.*—It may be stated at the outset that inundated land which receives a deposit of silt every year is never manured: nor is land newly reclaimed from jungle. But all lands which lie above the reach of the floods and which have long been under cultivation are invariably manured for sugarcane. The principal and in most parts practically the only manure used is cowdung. It is supplemented, wherever possible, with ashes and household refuse. The general practice is to spread the cowdung over the field before the ploughings commence, or in the intervals between the ploughings.

Cattle-folding is practised in the vicinity of large pasturage grounds, but the practice is not at all common. In the Assam Valley, the field is manured with cowdung in the beginning when it is being prepared and repeated doses of powdered cowdung are given to the young crop at the time of hoeing. The same custom obtains among the cane-growers of Dacca, but they do not use powdered dung like the cultivators of Assam.

Cane-fields on the banks of the Dulai creek near Dacca City are manured with heavy dressings of earth taken from the creek. It is said to be an excellent manure. Tank earth is occasionally used for manuring sugarcane fields.

Rape or mustard cake is the only oil-cake which is ever used as manure in Eastern Bengal and Assam. Except in Sylhet and Mymensingh and among the cane-growers of Dacca, the use of oil-cake for sugarcane cannot be said to be at all general, though its use as such is known everywhere. Oil-cake is always used in the powdered state. It is applied in small doses to the roots of the growing cane, when the crop is being hoed or earthed up. There is no information as to the quantity of oil-cake which a cultivator would ordinarily use per acre. The price of oil-cake in Eastern Bengal and Assam may be said to vary ordinarily from Re. 1 to Rs. 1-8, but this year it has risen quite 50 per cent. above the normal price.

The cultivators of Eastern Bengal and Assam are very careless in the matter of conserving cowdung for manure. The usual practice is to throw down the manure on a heap outside the cowshed and leave it exposed to rain and sun. In most parts of the Assam Valley and the inundated parts of Eastern Bengal, very little use is made of cowdung, the greater part being absolutely wasted. The only crops ever manured are sugarcane and vegetables. A happy exception to this rule is found in the Jorhat and Golaghat sub-divisions of the Sibsagar district, where the land has been impoverished by continuous cultivation, and the cultivators have begun to pay attention to the supply and conservation of cattle manure. The dung is kept in pits which are protected from rain by thatched roofs, and is powdered before being used for sugarcane. Cowdung is seldom used as fuel in the Assam Valley, even when it is not used as manure.

The trash or dried leaves of sugarcane is nowhere utilised as manure. It is invariably burnt either in the field after the crop is removed or in boiling the juice.

The use of green manure, either before or after planting sugarcane, is totally unknown in Eastern Bengal and Assam.

The only trustworthy experiment in the use of artificial manures on record is one made with superphosphate on the Rangpur Farm in 1905-1906. It was found that a dressing with 3 maunds of superphosphate—costing Rs. 10, increased the yield of jaggery by 9 maunds and 32 seers, which at the least valuation meant an increase of profit of Rs. 40. Certain manurial experiments with sugarcane are now being made in the Rajshahi Farm, but the results will not be known till a month or two hence.

25. *Treatment of the canes during growth.*—The operations to be dealt with under this head are trashing, wrapping the canes with leaves tying the canes to one another or to bamboo supports to prevent them from falling down and protection of the crop from jackals and other wild animals. Trashing is done in most places, but it is often neglected in case of the thin hard-rinded canes which are planted in close lines and taken little care of. Wrapping is a less common practice. It is never done with the thin hard canes, but the softer kinds are always wrapped wherever the crop is liable to much injury from wild animals. With these canes, it is found necessary to tie a number of clumps together to prevent them from falling. Bamboos are occasionally used for supporting the clumps, but the use of props is not at all common, except with chewing canes which grow to a great height and require artificial support.

Jackals are fought by various means, of which wrapping the canes is one. The field is fenced in many places with a closely woven bamboo paling sufficiently high to prevent the jackals from jumping over them. Thorny plants are used in places to strengthen the fence. It is usual to watch the cane-field at night. Jackals are scared away by beating tins. There are various other devices for creating noise to frighten away these animals. One

reported from Nowgong is a kind of improvised clatter or bell consisting of an inverted tin canister inside which hangs a heavy piece of wood. The tin is suspended by a rope from a bamboo post, and as it sways to and fro with the wind, the piece of wood hanging inside strikes against the sides and produces a clattering sound. Another in common use consists of a bamboo, the upper half of which is split into two half way down. It is fixed to the ground. One of the split ends is fastened to a rope. A man sitting inside his hut pulls the rope and then lets it go, causing the two halves of the bamboo to clap each other with force and make a violent noise.

Traps or baits are seldom used for killing jackals. It is the custom in many places to plant hard-rinded cane on the outside and the softer cane on the inside of the field to protect the latter from jackals.

26. *Treatment of the field preparatory to reaping the canes.*—The field receives no special treatment preparatory to reaping, and the irrigation of cane being unknown, nothing can be said as to the effect of watering the crop immediately before reaping.

27 *Disease phenomena.*—The most serious pests and diseases of sugarcane in Eastern Bengal and Assam are the jackal, the white ant, the red smut and the mothborer. In certain parts, wild pigs prove extremely destructive to sugrcane, and even the hardest varieties of cane cannot escape from their ravages. In Assam sugarcane is often damaged by wild elephants.

No serious attempt is made by the cultivators to cope with any of the diseases and pests except jackal (see paragraph 25).

28. *Diseases affecting the sets after planting.*—The only serious pest is the white ant. It attacks cane in all stages In Rangpur, the sets are sometimes washed in a mixture of kerosene oil and water as a preventive againse white ants, and the insects are picked off when they appear. In Sylhet, paddy husk is sometimes applied to the roots, and in places diluted cow urine is used as a remedy. Rape cake is believed in Assam to be efficacious for white ants, and is applied in small doses to infested plants. Land which annually goes under water is free from white ants. Jackals do not cause any appreciable injury to sets or to young cane, and it is not till the cane has attained some sweetness that they turn their attention to the crop.

The pine-apple disease is not known in Eastern Bengal and Assam. Red smut is known. In Faridpur, the cultivators are said to examine the sets for red smut, and those found to be affected by it are thrown away. None of the other district reports mentions this practice.

29. *Diseases affecting the whole plant.*—The *sereh* disease of Java is happily still unknown in the Province. It is reported from the Nowgong district that a kind of parasitic fungus is occasionally found on the roots of sugarcane and checks the growth of the plant. The black smut locally known as *andhar sap*, has been reported only from the Kamrup district. The disease is said to "turn the plant into a black powdery-mass." From the description it seems the disease is not black smut (*Ustilago sawchari*), but may be what Dr. Butler has described as "sooty" mould in his bulletin on the fungus diseases of sugarcane. A thin hard variety of cane known as the *majara* or *malaha* in Assam is peculiarly subject to sooty mould, the cane being covered with a dense black powder which comes off on rubbing.

The moth-borer is a common sugarcane pest in Eastern Bengal and Assam. It has been reported from most districts of the province. The insect is known as *majakata* in Assam, and *manjera* in Bengal. Other local names are *mandarkera* in Mymensingh and *mandarluri* in Noakhali. Most of these names imply an insect eating the inside of the cane. It is described as living near the apex of the plant and causing the crown to wither. The insect is found in the upper joints of the cane, and is possibly the white-borer (*Scirpophaga auriflua*) described in pages 130—133 of Mr. Lefroy's Indian Insect Pests. Some of the district reports speak of *manjera* as the red-smut, and attribute the disease to an insect. The fact that red smut is often associated with a borer has been mentioned by Dr. Butler in his report quoted above; it is no wonder, therefore, that the cultivators should speak of red-smut as caused by an insect. Affected plants are sometimes cut and thrown away, but the cultivators are usually too careless and indolent to adopt such a laborious process. Near Dacca, cane

growers strew turmeric powder over the plants as a preventive of the pest. It is believed in Sylhet that a liberal manuring with oil-cake has the effect of driving away the pest, and that it is caused by manuring the field with fresh cowdung.

30. *Diseases confined to the underground parts of cane plants.*—Besides white ants, the grubs of a beetle called *karapoka* or *kerapoka* are reported from several places as causing injury to the young shoots. An insect called *gata-bhur* is said to feed on the roots of growing plants, but no description of the insect has been received. None of the district reports mention any flowering parasitic plant growing from the roots of the sugarcane plant.

31. *Diseases affecting the stems.*—The red-smut is universal over the Province. It is mentioned in almost every district report. In some districts the disease is known as *manjera*, a name which is also applied to the moth-borer. In Dacca it is also called *dhasa*, which literally means rot. It is known as *upara* in Noakhali and *sinduria* in Kamrup. The cultivators are aware of no means for fighting the disease when it appears. The rejection of cuttings affected with red rot at the time of planting has been recommended as a preventive remedy. As already mentioned, the cultivators of Faridpur throw away diseased cuttings at the time of planting and although the remedy is one which readily suggests itself to all interested in the cultivation of sugarcane, it does not appear to be generally followed. In Sylhet, there is an idea that plantain trees planted among sugarcane prevent the disease from spreading. The soft Bombay canes are more susceptible to red-smut than any other, and it is for this reason they are seldom cultivated for the manufacture of jaggery. The thin hardy varieties of cane (*Khari*, *Khagri*, etc.,) are the least affected by red-smut.

Stem-borer and various other insect pests have been mentioned in some of the district reports, but the descriptions of the insects are so meagre and vague that no useful purpose would be served by mentioning them in detail.

32. *Diseases affecting the leaves.*—No serious leaf disease has been reported. In Noakhali, an insect called *gun gunia* is said to eat up the leaves, but the insect has not been described, nor is the extent of injury known.

33. *Reaping —Time of cutting the canes.*—All that is known on this point has been stated in paragraph 9.

34. *Deterioration after cutting.*—The raiyats appear to be fully aware of the deterioration that results from delay in crushing the cane. Limited as their resources are, they try to crush the cane as soon after cutting as they can. The mill is set up close to the field, and as much cane is cut in a day as the mill is expected to crush during the next twelve or twenty-four hours. The normal practice is to reap the cane in the afternoon and crush it during the night or the following morning. In Lakhimpur, where sugarcane is cultivated on a large scale by Nepalese squatters, the cane is often allowed during the cold weather to lie for a week before it is crushed, and in Kamrup two or three days may often elapse before the cane can be crushed. Such delays evidently arise from want of means to crush the cane quickly, and not from any want of knowledge on the part of the cultivators.

35. *Mode of cutting the canes.*—Except when a ratoon crop is to be taken, the cane is cut as low down as possible. For ratoon, the cane is cut one to two inches above the ground. In cutting the cane, the old leaves are first removed, then the tops are cut off, and finally the cane. In some places the tops are removed after the canes have been reaped.

36. *Yield per acre in canes.*—None of the district reports affords reliable information on this point. But trustworthy data are available for Assam from the Annual Reports on crop cuttings which have been published since 1883-84. The average yield of cane in 1,810 experimental cuttings made during the nineteen years from 1883-84 to 1901-02, and covering a total area of 166·39 acres, was 19·832 lbs. or a little under 9 tons per acre. A large number of cuttings were carried out in the Assam Valley in 1882-83 in connection with a special enquiry made by the Director of Agriculture. The average of 24 cuttings made by District Officers gave a yield of 27·083 lbs. of cane, or a little over 12 tons per acre. The maximum yield obtained in these experiments was 19 tons and the minimum 6 tons per acre.

Part III.

Manufactures

37. *Manufacture of jaggery or gur.*—Three descriptions of mill are in use for crushing sugarcane in Eastern Bengal and Assam, *viz.*, (1) the iron mill, (2) the wooden roller mill, and (3) the *ghani* or wooden mortar and pestle mill, the same as is used for crushing oil seeds. Steam crushing mills are used in several large sugarcane farms in Chittagong and Sibsagar. Iron mills have been introduced within the last twenty years. They appear to have completely supplanted the primitive wooden mill in all the districts of the Rajshahi Division and in Faridpur, Bakarganj, Noakhali, the greater part of Chittagong Division and Cachar. The Nepalese cane growers of Assam use iron mills, though among the Assamese cultivators, the use of the wooden roller mill is still all but universal. The earlier type of iron-mills has two vertical rollers but it is slowly giving way to three roller mills, which are more effective. Most of the iron mills used in the Rajshahi and Dacca Divisions are supplied by Messrs Renwick & Co., of Kushtia. The firm maintain depôts of their own at different cane-growing centres, and let out the mills on hire to the cultivators. Iron mills are also imported from Calcutta by Bengali and Marwari traders for hiring out to their clients. It is seldom that a cane-grower purchases his own mill. Very often the mill is let out along with the boiling plant. The rate of hire varies from 8 annas to Re. 1 per diem, and the average expenditure on this account has been estimated in different districts at from ₹9 to ₹30 per acre. The charge would no doubt vary according to the description and price of the mill and the yield of cane per acre, and also according as it is let out with the boiling plant or not.

The following description of the wooden-roller mill is taken from a note by Mr. E. Stack, Director of Agriculture in Assam, written in 1883:—

"The crushing mill (called *kherkha* in Goalpara and *hal* in Upper Assam) is a rude but tolerably effective machine, and a quicker and less dangerous worker than the heavy beam-and-pestle arrangement of Upper India. It consists of two vertical rollers (*bhim*) placed in juxtaposition, with their lower ends resting in a flat trough (*bhoral*) scooped in a solid and heavy block of wood (*toljoli*) resting on the ground, while their upper ends pass through a rectangular space cut in a horizontal beam above *borioli* supported by uprights (*hol khota*) let through the lower block into the ground. The rollers are held in their places by vertical clamps (*ghara*) which grip them at the upper and lower ends, and are driven home by wedges (*khal*). The portions of the rollers which project the upper beam (*borjoli*) are grooved so as to work into each other on the principle of an endless screw. The driving power is a horizontal beam (*katari*) applied to the head of the taller or "male" roller (*matabhim*), upon which the shorter or female roller (*maiki bhim*) revolves in the contrary direction. The male roller is usually, if not invariably, that on the right hand as one faces the mill, and the direction of progress is from left to right, that is to say, the men at work walk round with the left shoulder inwards. The whole machine is made entirely of wood, without a nail or a piece of iron in its composition, and its value varies according to the kind of wood used. A mill can be built of tamarind wood for eight rupees, but in *jam* wood (*Eugenia jamholana*) it will cost twelve, and if *nahar* (*Mesua ferrea*) is used, as much as fifteen rupees.

"All being ready for crushing, the first thing the cultivator does is to bind two of the finest cane-stalks along the beam of the mill, as an offering to Viswakarma, the god of artificers. The canes are then passed through the mill in batches (*ana* or *kana*) of six or eight at a time, the juice falling into the trough, and thence through a hole on to a sloping wooden tray, which transmit it by a lip of plantain leaf to the earthen vessel placed to receive it in a pit dug below. In some places the tray (*rosdhara*) is circular in shape, with a raised wooden edge and a funnel-shaped escapement for the juice, but usually a simple slab of wood, slightly concave, is considered sufficient The working of the mill is accompanied by a loud and strident noise, which is welcomed by the raiyats as a sign that the rollers are biting well, and is moreover a cheerful and useful accompaniment while the work is carried on by night, as is the practice towards the end of the season when the heat of the day would be

injurious alike to the men and to the cane juice. Each handful of canes is passed through the mill three or four times until they begin to yield mere foam, where they are thrown aside, and a fresh batch take their place. *Mugi* and *pura* cann squirt out their juice plentifully on the first compression, and give less afterwards, while the harder and tougher *teliya* passes through almost dry, and only begins to yield juice to the second squeeze. At the third and fourth crushings the flattened canes are usually twisted into a rope, so as to prevent a bulkier body for compression. A boy sitting in front of the mill draws them out as they pass through the rollers, and hands them back to the man who sits behind and feeds the mill. Four or five men drive the machine, resting their hands on the beam, and pushing against it with the chest and shoulders. The force required to put the mill in motion was ascertained in one experiment made by Mr. R. T. Greer, Subdivisional Officer of Golaghat, to be 5 to 6 lbs. without cane, and 40 lbs. with *mugi* cane between the rollers, but 60 lbs. with *teliya*. The rate of progress in crushing is about 2 maunds (165 lbs.) per hour. A good deal of trash and impurity-earth from the imperfectly cleaned canes, fragments of the stalk, dust carried by the wind, etc., enter the earthen pot along with the juice; in fact after a couple of hours work, mud can be plentifully scraped off the plantain-leaf lip of the tray, but the raiyats seldom trouble themselves to clean it. When the pot is full it is changed for another. As the work proceeds, the wedges holding the clamps have usually to be driven home from time to time, to counteract the tendency of the rollers to work asunder."

The wooden-roller mill is extensively used all over the Assam Valley except by the Nepalese cultivators, and it is also used by the indigenous cane-growers of Sylhet. It is also in use in the more backward parts of the Dacca and Chittagong districts.

The *ghani*, also called *kalhu*, is used in Noakhali and parts of the Dacca district. It is worked by bullocks in the same way as in crushing oilseeds. The canes are cut into two or more pieces to prepare them for the mill.

No experiments are known to have been made in Eastern Bengal and Assam to show the comparative yields of juice expressed by the different mills. The three-roller iron-mill is more effective than the two-roller. The District Engineer of Rangpur reports that with the softer varieties of cane the expression obtained by the three-roller mill may amount from 65 to 75 per cent. of the weight of the cane, while the two-roller may not be able to express more than 58 per cent. A very large number of experiments made in the Assam Valley during the 19 years from 1883-1884 to 1901-1902 gave an average expression of 47·48 lbs. of juice per 100 lbs. of cane with the wooden-roller mill used in that valley, and in some experiments as much as 60 per cent. of juice was obtained. The great majority of these experiments appear to have been made with the medium soft yellow *mugi* or *mag* cane of Assam.

Earthen pots are generally used for catching the juice as it comes out of the mill. Kerosine tins are now used in many places for this purpose, and brass and wooden pots are also occasionally used.

The juice is never kept longer than is necessary to get a sufficient quantity to fill the boiling pan. This would often mean a delay of four to six hours. The Nepalese cane-growers in Lakhimpur often allow the juice to stand over from 10 to 12 hours in winter and from 4 to 5 hours in the hot weather.

The juice is always strained when it is poured into the boiling pan, and in places also when issuing from the mill.

Special collecting pans are used only in the Assam Valley. The pan is a boatshaped vessel scooped out of a log of wood. It stands at the edge of the boiling-house, a few yards removed from the mill, and sometimes contain leaves of the wild fig tree, which are supposed to be useful in keeping the juice sweet. The juice is transferred to the boiling pan when some 12 to 15 gallons have been collected. The vessel is never heated. In Eastern Bengal and Surma Valley, no special vessel is used for collecting the juice as it accumulates, but in some places, each pot or tin as it gets filled with juice is poured into the boiling pan, and the juice is kept simmering till the pan is full, when the full heat is applied, and the juice begins to boil.

Nowadays, shallow circular iron pans are used in many parts of the province in preference to the earthen pans which were universally used at one

time and which are still in use in the more backward parts of the province. It may be generally said that wherever the iron sugar-mill is in use, the shallow circular iron pan is in use as well. The two go together, and in many places they are let out together to the raiyats. Deep hemispherical earthen pans usually arranged in batteries of two, three or four, are still used in different parts of the province. In a few places brass or iron vessels of similar shape have taken the place of earthen pans. In Faridpur, there is an objection against the use of the iron evaporating pan. It is said to make the *gur* blackish and give it an acrid taste. The boiling plant used in Rangpur consists of a large circular iron vessel about 6 feet in diameter on the top and 3½ feet at the base, and 18 inches deep. It is used in conjunction with an iron *korha* of semicylindrical shape, 18 inches in diameter and divided into three equal compartments. In place of the iron *korha*, a battery of three earthen pans may be used, along with the large circular pan already described. When a large quantity of juice is to be boiled, two iron *korhas* or two batteries of three earthen vessels each may be used. The juice is at first put in the main boiling pan and heated for about half an hour. It is then removed to the three compartments of the iron *korha* in equal proportions, leaving about 10 to 12 seers in the main pan. When the juice in this pan is sufficiently concentrated, the contents of the nearest compartment (No. 1) of the iron *korha* are transferred back to the main pan in small quantities at a time, the juice from the second compartment being transferred to compartment No. 1, and that of No. 3 to No. 2 at the same time. This process goes on until all the juice from the iron *korha* has found its way back to the main pan. Near Dacca, the boiling pan is a semicylindrical iron vessel of the same shape as the iron *korah* of Rangpur, but it is not divided into compartments like the latter, and is used singly.

In the open thickly-peopled parts of the province, where wood is scarce, megass and trash form practically the only fuel used in boiling the juice. During the first day or two, other fuel would be necessary to make a start. In the Assam Valley, the hilly tracts of Sylhet, Noakhali and the Chittagong Hill Tracts megass or trash is seldom used, fuel being abundant in those parts. The use of megass or trash as manure is mentioned in none of the district reports. In many places, the trash is burnt on the land; it is never ploughed in as manure.

The scum which rises in the beginning of the boiling operation is everywhere removed, and it is either thrown away or given to cattle. The scum which rises in the later stages of boiling is skimmed off in most places, and is used generally for mixing with tobacco. In the Assam Valley, the cultivators are less careful in the matter of removing the scum.

Generally, the raiyats of Eastern Bengal and Assam do not use any substance for defæcating the juice. When *gur* of specially good quality is to be made, the juice is cleared by the addition of a little milk at the time of boiling. The use of lime has been reported from several places (Faridpur, Dacca, Rajshahi, Chittagong Hill Tracts, Sylhet and Nowgong), but its use cannot be said to be at all general. The difficulty in using lime is to ascertain the exact quantity which should be used, as the slightest excess turns the *gur* black. Soda and *khar* (impure carbonate of potash obtained by burning plantain leaves) are used in a few places for clarifying cane juice. In Nowgong *khar* and lime are used only in case of damaged canes to neutralize the excessive acidity of the juice. In Sylhet, the juice of *simul* bark (*Bombax malabaricum*) is occasionaly used as defæcant. The juice of the *bhindi* plant (*Hibiscus esculentus*) is used for the same purpose in the Chittagong Hill Tracts

The usual form of jaggery made in Eastern Bengal and Assam is the semi-liquid *gur* known in Bengal as *dánd* (or crystal-mixed) *gur* and in Upper India as *rdb*. Solid *gur* (called *dhima gur* in Rangpur) is prepared in certain localities; the *jaggery* is moulded into blocks or cakes of various shapes and sizes by being poured into pits dug in the ground and lined with sacking cloth or leaves or into pots or bamboo baskets of various shapes, and is taken out after it has cooled down into a solid mass. In certain parts of Sylhet a kind of *jaggery* called *lali* is prepared; it is more of a syrup than *gur*, and is either used as such or sold to wholesale traders who reboil it into the usual form *of gur*.

For ordinary *gur*, the correct point in boiling is ascertained by various means. The chief among these is the size and appearance of the bubbles which are known at different stages by different names. For instance, in Assam three stages are marked by the size and shape of the bubbles. These are vulgarly known as *ophulia*, *babori phulia* and *temi mulia*, implying that the bubbles in the first stage are as large as the fruit of the O tree (*Dillenia indica*), that is, about 3 inches in diameter; in the second stage they are more frequent and shrink to the size of the *babori* flower (*Chrysanthemum coronarium*, a pot herb); while in the final stage, they present a hollow in the centre and are thus compared to the little box (*temi*) in which the Assamese peasant carries his stock of lime for chewing with betel-nut.

There are other methods for ascertaining the correct point in boiling. A little *jaggery* is taken up with a stick; if it falls in drops, the *gur* is still too thin; on the contrary if it falls in a continuous line and the line after descending some way is drawn back towards the stick, the boiling is complete Experts can tell the correct point by feeling a drop of *gur* between the fingers. If a little of the boiling mass is thrown into cold water, and turns solid, instead of getting dissolved in the water, it implies that the *gur* has been sufficiently boiled.

The general practice is to cool the *jaggery* to some extent before it is transferred to the pots in which it is to be kept. In the Assam Valley, the liquid mass is received in a wooden vessel (*gholani*) about six feet long, and of the shape of a canoe with one end cut square; it is stirred up with a Y-shaped instrument consisting of a triangle of bamboo fastened to the end of a stick (*hal bari* or *ghatani mari*). As the stirring continues, the liquid loses its dark brown colour, and assumes the hue and consistency of yellow mud. The process lasts half an hour. In those places where the shallow circular boiling pan is used, there is no special vessel for cooling the *jaggery* in. The pan is taken out of the fire, and the jaggery is stirred with a stick till the desired colour and consistency has been attained. Earthen and brass vessels are used in some parts for stirring and cooling the *jaggery*.

Semi-liquid and liquid *jaggery* are kept in earthen pots of various shapes and sizes. As a rule, no special care is taken to preserve *jaggery* beyond closing the mouths of the pots with earthen saucers and plastering them up with cowdung and mud. In Sylhet, solid *gur* is preserved by covering it with straw and plastering it over with cowdung and earth.

The usual price of *gur* in the different districts has been returned as follows. The figures denote the price per maund of 82⅔ lbs.

	Rs.	
Rangpur	4 to 8	
Rajshahi	4 „ 4-8	
Dinajpur	4 „ 5	
Pabna	4 „ 5	
Dacca	6 „ 7	
Faridpur	3 „ 5	
Chittagong	5 „ 8	
Chittagong Hill Tracts	4 „ 6	
Tippera	6	
Cachar	4 „ 5	
Sylhet	3 „ 3-8	in Longai and Singla Valleys (cane growing centres) and Rs. 4-8 elsewhere; *lali gur* Rs 5.
Goalpara	6-4 „ 10	(retail).
Kamrup	5 „ 7-8	„
Nowgong	4-6 „ 7-8	„
Lakhimpur	2-8 „ 6-4	

The prices will be found to vary within wide limits. *Jaggery* sells cheapest in the Dibrugarh subdivision of Lakhimpur, where sugarcane is cultivated on an extensive scale by Nepalese immigrants, and in the Longai and Singla Valleys of Sylhet and the northern parts of the Faridpur district.

Lakhimpur exports a large quantity of *jaggery* to different places in Assam. A great deal of *jaggery* is exported from Sylhet to Tippera, from Rangpur to Assam and different districts of Eastern Bengal and from Faridpur

to Dacca, Tippera and Bakarganj. Much of the *gur* consumed in the southern districts of Eastern Bengal is date *jaggery* imported from the Jessore district in Central Bengal. The high price of *jaggery* returned by some of the Assam districts is due to the fact that the article is usually sold retail by the cultivators and is seldom sold to wholesale dealers. The same may also be the case in other places.

There is no export of *jaggery* from Eastern Bengal and Assam to places outside the Province; on the contrary, a large quantity of *jaggery* as well as of refined sugar has to be imported annually from Bengal and the United Provinces to supplement local production, as will appear from the statistics quoted below.

For trade purposes, Assam and the transferred districts of Bengal, (*viz.*, Dacca, Rajshahi and Chittagong Divisions) have been hitherto considered as separate areas. The latter till recently formed part of Bengal and were included in three large trade blocks—Eastern Bengal, Northern Bengal, and Dacca—which covered, besides, a few districts of Bengal. The statistics of trade of these three blocks which will be quoted in this report should, therefore, be regarded as applicable to a somewhat larger area than the present sub-province of Eastern Bengal. They also exclude the trade by river between the blocks and the rest of Bengal (except Calcutta), which has never been registered. The plains districts of Assam are divided into three trade blocks—the Surma Valley, comprising the districts of Sylhet and Cachar, Upper Assam and Lower Assam, the last two comprising all the districts of the Assam Valley.

The average annual imports of raw sugar (*jaggery*) into the Assam Valley for the five years ending with 1905-1906 amounted to 101,409 maunds, out of which 78,467 maunds came from Bengal, and almost the whole of the rest from the United Provinces. During the same period, the imports of raw sugar into the Surma Valley amounted to an annual average of 225,330 maunds, all but 119 maunds of which came from Bengal. In these statistics, the imports from Bengal included those from Eastern Bengal, and there is no means to distinguish between the districts which now remain to the present Province of Bengal and the Eastern Bengal districts of this Province.

The imports of raw sugar into the three trade blocks of Eastern Bengal, Northern Bengal and Dacca amounted on the average of three years ending with 1904-1905 to 933,224 maunds, distributed as to their origin as below :—

	Mds.
Calcutta	497,562
United Provinces	246,105
Behar	183,767
Rest of Bengal and other parts of India	5,790
TOTAL	933,224

The imports of refined sugar of country and foreign origin will be dealt with in paragraph 40.

38. *Profit and loss on sugarcane cultivation.*—The normal yields of *jaggery* per acre are given below for each district of Eastern Bengal and Assam. These have been obtained from the latest quinquennial return of normal yields of crops.

	lbs.
Eastern Bengal—	
Jalpaiguri	2,000
Rangpur	2,800
Dinajpur	2,400
Malda	2,800
Rajshahi	2,400
Pabna	2,800
Bogra	2,400
Mymensingh	2,100
Dacca	2,400
Faridpur	2,400
Bakarganj	2,000
Tippera	2,100
Noakhali	2,400
Chittagong	2,000

Assam—

Cachar	2,200
Sylhet	2,400
Kamrup	1,800
Darrang	1,800
Nowgong	1,800
Sibsagar	2,200
Lakhimpur	2,400

The normal rate of yield in Eastern Bengal as a whole is taken at 22 cwt. or 2,464 lbs. per acre, and in Assam at 2,200 lbs. per acre. These are to be regarded as the normal or average yields of *jaggery*. Some of the district reports mention much higher yields, and although these have been reported as average yields, they no doubt represent the usual outturn that is expected from a good crop. Thus, the Collector of Faridpur gives 30 maunds of *jaggery* as the produce of one *bigha* or one-third of an acre, at Pangsa in the Goalundo subdivision and 24 maunds per *bigha* in the Sadr subdivision of his district. Calculated to the acre, these yields would amount respectively to 7,200 lbs. and 5,760 lbs., which are 3 and 2½ times as much as the accepted average for the district. The Superintendent of the Chittagong Hill Tracts returns the yield of one acre of cane at 100 maunds or 8,000 lbs. of *jaggery*. The area under sugarcane in that district is yet too small to affect the provincial average. From the Superintendent's report it would appear that the soil and climate of the district are eminently adapted to the cultivation of sugarcane.

Estimates have been received of the cost of cultivation, manufacture and outturn from several districts of the Province, but very few of these can be accepted as sufficiently trustworthy. With one or two exceptions, all the estimates are so far agreed that the cultivation of sugarcane leaves a handsome net profit to the cultivator. A few of the more carefully prepared estimates are quoted below :—

At Pangsa in Faridpur.

	Rs.	a.	p.
Rent	3	12	0
Ploughing 12 times and harrowing	18	0	0
Manure and cost of spreading it	16	0	0
Seed cuttings, 15 *kahans* (*kahan*=1,280)	39	0	0
Cost of planting (36 men at 4 annas)	9	0	0
After cultivation, including tying up	25	8	0
Total cost of cultivation	113	4	0
Reaping and manufacture (inclusive of cattle)	60	0	0
Other expenses	6	0	0
Rent for mill	9	0	0
Earthen jars	6	0	0
Total cost of manufacture	81	0	0
Grand total of cost	194	4	0
Outturn : 90 maunds of jaggery at Rs 3	270	0	0
Net profit	75	12	0

In the neighbourhood of Dacca City.

	Rs.	a.	p.
Rent	3	12	0
8 ploughings and harrowings	15	0	0
Cost of manure (150 maunds of dung)	7	8	0
Seed cuttings (19,500 at Rs. 2 per 1,000)	39	0	0
Cost of planting cuttings in seed bed, making pits, transplanting, and watering	27	0	0
After cultivation and fencing	19	8	0
Total cost of cultivation	111	12	0

	Rs.	a.	p.
Reaping (96 men)	36	0	0
Hire of 3 pairs of bullocks for 9 days	10	2	0
Fuel	3	0	0
Hire of mill and pan for 9 days at 12 annas	6	12	0
Quick lime	0	3	0
Earthen pots	7	8	0
Contingencies	9	0	0
Total	71	9	0
Grand total of cost	183	5	0
Outturn 45 maunds of *gur* at Rs 6	270	0	0
Net profit	86	11	0

To this may be added another Rs. 30 from the sale of cuttings, after keeping enough for the raiyat's own field.

In new alluvial soil in Rangpur.

	Rs.	a.	p.
Rent of land	3	12	0
12 ploughings with harrowings	25	5	0
Cowdung 450 maunds Rs. 15, and cost of applying 3¾ men at 6 annas	16	6	6
Seed cuttings, 7½ *kahans* (*kahan*=1,280) at Rs. 4	30	0	0
Cost of seed beds, transplanting	12	3	0
After cultivation (2 weedings, 2 ploughings, filling up blanks, 4 tyings and 150 bamboos)	50	10	0
Total cost of cultivation	189	0	6
Harvesting and *gur* making, 105 men at 8 annas	52	8	0
Fuel for first day	3	0	0
38 earthen pots	12	5	0
Hire of mill and bullocks	30	0	0
Cost of clearing roots for next crop by ploughing	8	7	0
Total cost of manufacture	106	4	0
Grand total of cost	245	4	6
Outturn 59 maunds at Rs. 5-5-8	315	0	0
Net profit	69	11	6

In old alluvium the cost of cultivation is a little more, and the outturn is less, the net profit may be Rs. 45 to 50 per acre

In Tippera.

	Rs.	a.	p.
Rent	4	8	0
Seed cuttings	40	0	0
Cowdung 36 cart loads	12	0	0
8 ploughings, hoeings and weedings	20	0	0
Fencing	4	0	0
Total cost of cultivation	80	8	0
Reaping and fetching home	50	0	0
Cost of milling	20	0	0
Earthen pots	6	4	0
Total cost of manufacture	76	4	0
Grand total of cost	156	12	0
Outturn 35 maunds of *gur* at Rs. 6	210	0	0
Net profit	53	4	0

To this may be added the income from the sale of cuttings, which is estimated at Rs. 60.

In the Dibrugarh sub-division of the Lakhimpur district, the cost of cultivation by Nepalese cane-growers per *pura* (1⅓ acres) is estimated as follows for three years in succession :—

	1st year.	2nd year.	3rd year.
	Rs. a. p	Rs. p. a.	Rs. a. p.
Cultivation—			
Land revenue	2 4 0	2 4 0	2 4 0
Jungle cutting (one month's wages of one labourer)	12 0 0	...	...
Planting (ditto)	12 0 0	...	...
Price of seed	20 0 0	...	...
Weeding and hoeing 3 times (3 months' wages of one labourer)	36 0 0	36 0 0	36 0 0
Total	82 4 0	38 4 0	38 4 0
Manufacture—			
Labour for reaping, crushing and boiling (one month's wages for three labourers)	36 0 0	36 0 0	36 0 0
Hire of mill, pan, and buffaloes	15 0 0	15 0 0	15 0 0
Earthen pots	6 0 0	16 0 0	16 0 0
Total	57 0 0	67 0 0	67 0 0
Grand total of cost	139 4 0	105 4 0	105 4 0

The total cost for the three years amounts to Rs. 349-12, or say Rs. 350. The outturn is estimated for the first year at 150 pots and for the second and third year at 400 pots each. Each pot holds from 6 to 8 seers of *gur* or say 7 seers in the average. The total outturn of *jaggery* in the three years, therefore, amounts to 166 maunds and the average price per pot being 12 annas, the total estimated income amounts to Rs. 712-8. Calculated to the acre, the cost of cultivation would be Rs. 119-1, and of manufacture Rs. 143-4 and the whole cost from commencement to end Rs. 362-5. The outturn of *jaggery* would be 712½ pots valued at Rs. 534-6, which would leave a net profit of R272-1 per acre in three years, or about R90 on the average per annum. During the first year of cultivation, there is a net loss, which is more than made up by the profit of the ratoon crop in the two following years.

The following is an abstract in round figures of the estimates quoted above :—

—	Cost of cultivation per acre.	Cost of manufacture per acre.	Total cost per acre.	Yield per acre.	Value of yield per acre.	Net profit per acre.
1	2	3	4	5	6	7
	Rs.	Rs.	Rs.	Mds.	Rs.	Rs.
Faridpur (Pangsa)	113	81	194	90	270	76
Dacca (near City)	112	71	183	45	270	87
Rangpur (new alluvium)	189	106	245	59	315	70
Tippera	81	76	157	35	210	53
Lakhimpur (Dibrugarh, average of three years)	40	48	88	42	173	90

Comparing the cost of cultivation and net profit in Dibrugarh with those of other districts, the extremely profitable character of cane cultivation in the virgin forest soil in that subdivision would be at once evident. But the system

of cultivation which the Nepalese pursue results in the wholesale destruction of forest, and it cannot be expected to continue for an indefinite time. The cost of cultivating forest land is so low that a few years ago *gur* was selling in the Dibrugarh market at such a low price as R2-8 per maund. Unfortunately, the Nepalese cane-growers are in a state of chronic indebtedness to Marwari money-lenders who appropriate a large share of the profits that would otherwise remain to the cultivators.

39. *Character and richness of the juice.*—There is no analysis on record of the richness and purity of cane-juice in Eastern Bengal and Assam. In the experimental harvestings of sugarcane made in Assam during the nineteen years from 1883-84 to 1901-02 to which reference has been more than once made, the outturn of *jaggery* was found to average 8·42 per cent. on the weight of cane and 17·73 per cent. on the weight of juice. In some instances, 50 to 60 per cent. of juice and 10 to 13 per cent. of *jaggery* has been obtained from a given weight of cane, but these should be regarded as exceptional cases, and do not represent the sugar-yielding capabilities of the common cane of the Assam Valley.

40. *Sugar-making.*—Sugar is produced on a very small scale in Eastern Bengal and Assam. The only districts where it is known to be manufactured are Rangpur and Faridpur. The process of manufacture followed in Rangpur is as follows. The *jaggery* is mixed with water and boiled for an hour or so. The scum that arises is removed, and the concentrated mass is churned till it becomes reduced to powder. The resulting sugar (if sugar it can be called) is known as *bhura*. A better class of *bhura* is prepared by placing the *jaggery* in four bamboo baskets placed one above another and covering it with a kind of grass locally called *khar*. An earthen vessel is placed below to receive the treacle. After an interval of two days the *khar* is removed, and the sugar, which forms a coating an inch or so thick on the surface, is scraped off. Fresh *khar* is then placed on the exposed surface and the process repeated three or four times. The scraped mass is reboiled with water, the syrup being clarified with the help of milk; and when sufficiently thick it is churned into a powdery mass.

The process of manufacture followed in Faridpur is described in the following extract taken from Dr. Watt's Economic Dictionary:—

"The process of refining sugar is the same, whether it is obtained from the juice of the date or of the cane. Two modes of manufacturing sugar from *gur* are reported on. By the first method, the boiled juice in the form of *gur* is placed in stout gunny or sackcloth bags. The molasses or refuse is squeezed out partly by twisting and tightening the mouths of the bags and partly by laying weights upon them for additional pressure. The article thus produced is of a brownish colour. By far the largest quantity of sugar manufactured in the district, however, is prepared in a different way. The process, rather a cumbrous one, is as follows:—The *gur* is at first boiled with a certain proportion of water in a large iron vessel, a quantity of diluted milk being added from time to time to separate the impurities, which are skimmed off as soon as they form on the surface. When no more skim appears, the thickened liquor is poured into a number of circular earthen pots or strainers, made wide at the top and pointed below, with a hole in the centre, called *bharnis* and left for two or three days in the open air to cool. It is then removed to the refining house, where the final separation of the solid crystalline portion from the treacle is effected. The straining pots are generally arranged in rows on a bamboo frame at a certain height from the ground, and earthen pitchers are placed under each to receive the molasses as it slowly drains from the refining pot above. To complete the arrangement, as well as to quicken the operation, fresh moist leaves of a water weed called *pata saola* are now placed on the top of the refining pot, and as soon as a layer of sugar from one to two inches thick is formed at the top, it is removed by scraping with the knife, fresh weed being laid on the remainder, and the same tedious process is repeated several times until the entire quantity of sugar is made. The native confectioner makes extensive use of this sugar for the purposes of his art; but before it is fit for use, it has to be clarified again by further boiling with the addition of a solution of milk as in the last process. When this is allowed to cool, it forms a hard crust which requires to be broken and pounded before it can be

employed. The molasses which drains off from the sugar in the process is employed for preparing *hooka* tobacco, inferior sorts of sweetmeats, etc., and the rest is sold for making country rum."

There is no sugar factory in Eastern Bengal and Assam which is equipped with modern machinery, if we leave out of consideration the few sugarcane farms in Chittagong and Sibsagar, where steam-power mills are employed in crushing the cane. Very little information is available about these farms or about the exact character of the machinery employed. The Barpather farm in the Sibsagar district grows cane for its own mill and does not purchase any from the neighbouring raiyats. The same is probably the case with the cane-planters in Chittagong. *Jaggery* is the only product produced in these farms.

Two old rum or sugar factories existed many years ago at Gauhati and at Dobapara in the Goalpara District. Nothing is known at this day of their history or of the cause of their failure. The efforts of Mr. Herriot, who owned the factory at Gauhati, to introduce a better kind of cane were so far successful that the best cane of the present day in Kamrup and Darrang traces its origin to them. There also existed in the eighties two rum factories near Golaghat and Dibrugarh. Situated as they were in the centre of thickly-peopled tracts, these factories stimulated the production of cane considerably within the limited area on which they drew for their supplies of *jaggery*.

The crushing of oilseeds, cotton-ginning and rice-husking are industries which can be suitably carried on in a sugar factory during the season when the machinery would have to remain idle.

We might get an answer to the question as to what price the raiyat will be willing to accept for his canes placed at the factory door from a consideration of the cost of production and the profit which he can reasonably expect therefrom. The cost of transport to the factory should also be taken into consideration. We may assume that the yield of *jaggery* is 10 per cent. on the weight of cane, and that the raiyat would expect 20 per cent. on the cost of cultivation as his profit (besides being remunerated for his own labour). The cost of transport would vary with the distance from the field to the factory. Taking the average distance to be (say) 3 miles, the cost of conveyance by cart may amount to about an anna per maund. Now, if we turn back to the estimates of cost of cultivation quoted in paragraph 38, we may calculate the cost of a ton of cane as below :—

	Yield of cane (ten times *jaggery*).	Cost of cultivation.	Add 20 per cent. for profit.	Add cost of transport at one anna per mound.	Total cost.	Cost per ton (27½ mds.)
	Mds.	Rs.	Rs.	Rs.	Rs.	Rs. a.
Faridpur . . .	900=33 tons	113	23	56	102	5 13
Dacca . . .	450=16½ „	112	22	28	162	9 13
Rangpur . . .	590=21⅔ „	139	28	37	204	9 7
Tippera . . .	350=12⅘ „	81	16	" 22	119	9 5
Lakhimpur . .	420=15⅓ „	40	8	26	74	4 12

The cost of a ton of cane would then seem to vary from about Rs. 5 to about Rs. 10. Whether it would pay a factor to pay for cane at the lowest of these prices is a question to which it is not possible to give an answer without knowing the cost of manufacture in a factory. The Agricultural Department does not possess any data on the subject. The cost of cultivation can no doubt be reduced to a considerable extent by improved cultivation; and it may not be too sanguine to expect that in favourable conditions a raiyat should be able to deliver cane at the factory door at Rs. 4 or even less per ton. If people could take their canes to a factory, and dispose of it there at a rate which would leave them a fair margin of profit, many persons who are now deterred by the cost and trouble involved in the crushing of sugarcane and the manufacture of *jaggery* would be induced to engage in the cultivation of sugarcane. The great majority of raiyats keep barely enough cattle to cultivate their holdings, and

cannot spare any for the crushing of sugarcane. Central mills, where the cane would be crushed by steam-power, are expected, therefore, to be popular, once the raiyats are persuaded to sell their canes instead of making *jaggery* for themselves.

There are several classes of refined sugar imported into the Province These are (1) country sugar, which comes mainly from the United Provinces and Behar and is ordinarily known as Benares sugar, (2) foreign sugar imported through Calcutta, (3) country date sugar from Central Bengal, and (4) Cossipore sugar from the Cossipore sugar factory near Calcutta.

The average annual imports of refined sugar into Assam during the five years ending with 1905-1906 amounted to 80,514 maunds; out of this quantity, 59,387 maunds came from Calcutta; and 6,725 maunds (Benares sugar) came from the United Provinces.

The three trade blocks already mentioned, in which Eastern Bengal is included, imported 565,264 maunds of refined sugar annually on the average of the three years ending with 1904-1905. Out of this quantity 508,680 maunds, or almost 90 per cent. was obtained from Calcutta. The balance of the imports was, for the most part, Benares sugar from the United Provinces and Behar.

It is not possible to ascertain the countries from which the sugar imported from Calcutta into Eastern Bengal and Assam was derived, but presumably the bulk of these imports was of foreign origin. It appears from a perusal of the Bengal Customs Reports that the countervailing duties on bounty-fed sugar imposed by Act XIV of 1899 had no visible effect on the importation of sugar from the continental countries of Europe. But it received a serious check when additional duties were imposed in 1902 to meet what is known as the cartel system. While the imports of beet sugar have greatly fallen off in recent years as the effect of these duties, those of cane sugar have steadily increased and more than made up the decrease in the imports of beet sugar. The bulk of the cane sugar imported into Calcutta comes now from Java, which has thrown every other sugar-producing country in the shade in the Calcutta market. *Pari passu* with the increasing imports, the price of imported sugar has fallen, with the result that the imports of sugar from Calcutta into the interior of the country have greatly increased in recent years, as will appear from the statistics of price and imports quoted below:—

Refined Sugar.

	Imports into Calcutta by sea	Average price per cwt.	Imports from Calcutta into Assam.	Imports from Calcutta into Eastern Bengal and Assam.
	Cwt.	Rs. a. p.	Mds.	Mds.
1896-1897	488,500	11 3 1	36,644	Not available.
1897-1898	1,068,878	11 4 5	41,475	
1898-1899	989,925	11 12 1	54,335	
1899-1900	750,965	10 13 1	38,973	
1900-1901	1,340,844	11 2 7	56,126	
1901-1902	1,511,727	10 2 10	41,506	
1902-1903	1,506,622	9 0 8	54,603	420,793
1903-1904	1,876,965	9 5 5	63,422	575,910
1904-1905	2,107,460	9 7 6	60 528	529,386
1905-1906	.....	.....	76,977	.....

PART IV.

IMPROVEMENTS.

Mr. Barber has suggested the various directions in which improvements may be effected. These are briefly considered below.

First introduction of new varieties of canes.—Any effort to introduce new varieties should necessarily be preceded by an investigation of their merits. It will be necessary to study their field, milling and chemical characters. A research of this kind can only be successfully carried out on a properly-equipped experimental station conducted on the same lines as the

sugarcane stations in the West Indies, under the control of the Imperial Commissioner of Agriculture and the Samalkota Farm in Madras. An experimental station to be devoted mainly to the sugarcane crop has been recently started at Jorhat in the Assam Valley, and it will be one of its main objects to investigate the merits of the indigenous varieties of cane and of new varieties imported from abroad.

Secondly, more careful attention to the details of cultivation.—Not much improvement is to be expected under the existing conditions of the country, so far as the tillage of the land and the after treatment of the crop are concerned. There is no doubt that the cultivation of sugarcane as practised in Eastern Bengal and Assam can be improved in many respects, but the general apathy of the agriculturists and the low standard of agriculture current in the province stand in the way. The use of rape-cake as a profitable manure for sugarcane appears to be known in most districts, and although it is available everywhere, it is but seldom used except in a few localities such as Sylhet. The reason why a manure so readily available is not used as widely as it could be is not quite clear. If it be that the raiyats are too poor to purchase the manure, the problem should be one which the rural Co-operative Credit Societies now being established might well take in hand. But it seems the real reason is not poverty, but is to be found in the fact that the cultivation of sugarcane in Eastern Bengal and Assam, though it may be less careful than in other parts of India, is still found to be so profitable that the cultivators have no stimulus to improve their methods.

Mention has been made of several large sugarcane farms in Chittagong and Shibsagar. The cultivation of these farms is decidedly less careful than what obtains among the cultivators. These farms consist of land newly reclaimed from jungle, and do not demand an intensive cultivation. But sooner or later the owners will have to adopt improved methods of cultivation if they intend to continue growing cane on the same land.

Thirdly, increased facilities for irrigation.—Not much is to be expected in this direction in Eastern Bengal and Assam. Most parts of the Province are sufficiently damp to be able to dispense with irrigation altogether. The old alluvium tracts in Northern Bengal and Dacca may be benefited by irrigation, but where so much land needing no irrigation is available, it is hardly to be expected that these tracts will be preferred for sugarcane cultivation. It is possible that the old alluvium soil is more suitable for sugarcane than the ordinary alluvial and deltaic soils of the country, and may pay better under an intensive system of cultivation than the latter. But the point is one on which no opinion can be expressed without a critical study of the methods and results of sugarcane cultivation in the two classes of soil.

Fourthly, improvements in the manufacture of jaggery or gur.—The quality of *jaggery* can certainly be improved, and by means which are well within the power of the raiyats. *Jaggery* of excellent quality is prepared at the Burdwan and Sibpur Experimental Farms. The same appliances as are used by the neighbouring cultivators are used, but attention is paid to a few simple details about which the raiyats are as a rule careless. The juice is received in pots, which are cleaned and sweetened every day; and as soon as the pot is full, the juice is poured into the boiling pan and kept sufficiently hot to prevent fermentation until the full charge has been collected. The pan used is of iron and of the shallow circular type now used in many parts of Bengal. The pan is so placed over the fire that its outer six inches or so projects beyond the furnace, the object being to prevent the burning of the jaggery as it thickens in the pan. After the juice has been clarified and the first scum that rises has been removed, the boiling is pushed on as fast as possible. This simple method, which entails no additional cost, can be further improved by defæcating the juice with the help of such substances as soda and the mucilagenous extract obtained by crushing the stems of the *bhindi* plant.

But unfortunately the raiyats are too slow to change their methods. The *jaggery* they produce is sufficiently good to meet the taste of the consumers. No general improvement is, therefore, to be expected until the public have acquired a taste for a better product.

It is doubtful whether refined sugar can be prepared on a large scale from country-made *jaggery* so as to be able to compete with imported cane and beet

sugar in the open market. The products of the Cossipore Sugar Factory do not enter into competition with imported sugar. The factory caters for a select class of customers, and has after all a very limited market. If India is to compete successfully with foreign countries in her own market, she should be able to produce sugar direct out of the cane. *Jaggery* has a very large market of its own, and its price is governed by causes other than the demand for it for refining purposes. Hence it will never be safe for a refinery to depend for its raw material on country *jaggery* if it has to compete with the outside world. It is said the Cossipore Sugar Factory has of late been using raw sugar from Java as being cheaper than the country product.

Fifthly, introduction of small plants for sugar-making.—The questions mooted by Mr. Barber are such that no opinion can be expressed without a minute study of the system of sugar manufacture followed in modern factories.

B. C. BASU,

Assistant Director of Agriculture.

SHILLONG.

The 28th January 1907.

APPENDIX.

Varieties of Sugar-cane

District.	Local name of variety.	Description.
1	2	3
Dacca	*Khagra*	White hard rind. Rich in sugar, is grown for *gur*.
	Deshi or *Nomi*	Looks like *Khagri*, but is thicker and softer, not so rich as *khari*, but produces better *gur*.
	White Bombay or *Ganderi* (chewing cane).	Rind very soft; internodes long; very sweet to the taste, and is used generally for chewing purposes, yields also very good *gur*.
	Sharony	Very soft rind; internodes long, tallest and thickest; rich in juice and best for chewing purposes.
	Kajli	Deep violet, with very hard rind; not liable to attacks of wild animals.
Bakarganj	*Ikri*	Ash-coloured, with hard rind; rich in sucrose; good for making *gur*; not liable to attacks of wild animals.
	Khagri	Very hard canes of reddish yellow colour; good for *gur*; resists disease, and not liable to attacks of jackals.
	Bombai or Turpin	Yellow, with soft rind; juice poor in sucrose.
	Nara	Red; rich in sucrose; liable to disease and attacks of wild animals.
	Kajla	*Pinkish* cane; poor in sucrose.
Faridpur	*Dhalsundar*	White with a reddish tinge.
	Kajla	Deep purple, with hard rind; can stand stagnant water; makes good *gur*.
	Khala or Lata	Yellow, with a shade of purple; hard and thin; too hard for jackals and white-ants; can stand stagnant water.
	Choona	Yellow; thinner than *khala*; *gur* produced is black.
	Khagri	Redish with hard rind; not liable to disease; produces good *gur*.
	Ikri	Yellow, can stand 8 feet water.
	Bombay	White, grows thick and very tall; a chewing variety.
Chittagong	*Chewing cane*	Soft rind
	Khari	Hard rind; grown for *gur*-making.
Tippera	*Khagra*	Greenish white; hard rind.
	Bombay	Red; soft rind.
	Dhalsundar	White, with dark blotches; hard rind; richest in juice
	Kajli	Red hard rind, richest in sucrose.
Rajshahi	*Khori*	Reddish brown; thinner than *Khagra*; soft rind; rich in juice and is grown for *gur*-making.
	Khagra	Dark colour, hard rind; rich in juice, and is grown for *gur*-making.
	Bombay	Purple; chewing cane; poor in sucrose.

APPENDIX—*continued.*

District	Local name of variety.	Description.
1	2	3
Dinajpur	*Saheban*	Reddish ; very soft rind ; rich in juice
	Patasi or Kajli	Deep purple with dark tinge ; hard rind ; not subject to attacks of wild animals.
	Kheri	Ash coloured ; softer than *Patasi.*
	Moogi	Pale brown ; soft rind ; rich in juice.
	Basna	Greyish ; hard rind ; poor in juice.
Bogra	*Bhelan Mukhi*	Reddish white ; cultivated for *gur.*
	Bombai	Yellow ; grown for chewing
Pabna	*Dhalsundar*	White
	Kajla	Red.
	Khaita	Ashy.
Malda	Chewing cane	Red.
	Chewing cane	White.
	Khagri	Greenish yellow
Rangpur	*Venda Mukhi*	Yellowish brown ; soft rind and tall ; gives high class of *gur.*
	Kajli	Purple ; harder than *Venda mukhi*
	Kheri	Thin and tall ; hard rind ; very rich in sugar and is grown for *gur*-making.
	Mugi Malsi	White ; hard rind ; poor in sugar.
	Samras	A small variety, with short internodes.
	Saheban	Red, with violet tinge, soft rind ; tallest and thickest, used for chewing.
Assam Valley Districts.	*Bagi*	White ; soft and juicy ; grows 7 feet long and the canes measure a little more than an inch in diametre ; makes good *jaggery.*
	Mugi or Mag	Amber colour ; otherwise same as *Bagi.*
	Rangi	Deep red ; hard and thin ; 5′ or 6′ high and ½ in diameter, hardy.
	Kali or Teliya	
	Bangala or *Bambo* or *Bam* (*Bombai cane*).	Red or yellow ; soft and juicy, grows 8′ long and 1½″ in thickness. An imported variety.
		Juice poorer than the preceding varieties, and cane apt to break into small pieces in crushing ; cultivated as a garden plant and eaten as chewing cane.
	Asmaiya or Ketekipura	A degenerate variety of *Bangala* or *Bombai* cane.
	Malaka Mahla, Magora, Megala or Majara (*reed cane*).	Hard, thin and dry. Requires no protection from beasts
	Bhabeli	Resembles *Mugi*, but with shorter internodes.
	Kamrangi	A cross between *Mugi* and *Teliya*
Manipur	*Tekhao-chu* (Assam-cane).	White, but sometimes violet. Soft, juicy and tall.
	Chu-nagang	Red, harder and thinner, and less juicy than *Tekhao-chu.*
	Awa	Yellow ; softer and larger than *Chu-nagang* ; introduced from Burma.
	Chunagaw	White, with soft rind, and is the softest variety.
	Hauchu	White, harder than *Chunagaw.*

Baroda State.

The cultivation of sugar-cane varies greatly in the different districts three distinct kinds of cultivation being practised in the Baroda, Naosari, and, Amreli Divisions of the State. Even within the districts, minor differences in practice are noticeable due to variations in soils.

Baroda District.

2. The average rainfall in Baroda is 30 inches distributed in one monsoon period from June to September. The average temperature is 50° mean minimum of January and 107° mean maximum of May, and the atmosphere is generally dry for the greater portion of the year.

3. The cultivation is practised from ancient times and no recent introduction of cane has been heard of in any part.

4. The area under sugar-cane was being gradually reduced even before the great famine of 1899-1900, but the reduction has been heavy since the famine which has reduced the capital of cultivators and the waters in wells, and increased the attack of white-ants. The area in 1905-06 was 128 acres against 724 acres before the famine.

The cultivation of cane is fairly intensive and takes its place in regular rotations. The soil is alluvial of a rather sandy character. In the preparation and manuring of land, in the adoption of the system of rotation, in the selection of seed and in the system of irrigation, cultivators seem very well up.

5 & 6. Only a red hardy variety of cane is generally grown, the full grown cane is 8 to 12 feet long and has a diameter of $1\frac{1}{2}$ to 2 inches. It has a hard rind and is moderately juicy. It stands the ravages of jackals, grubs, borers, &c., better than white canes which were tried by people in various places on account of their superior qualities, and given up as unsuitable.

7. At times sports have been found, *e.g.*, a whitish colour was found in red canes in isolated places, but no attempt seems to have been made to multiply them. Similarly inflorescence does appear in canes at times and seeds are formed from it, but in trials by some curious cultivators, the seed has failed to germinate.

8. No sugar is made in the district, jaggery (*gur*) of a very superior kind being made from the cane. Sorghum has been tried and given up as the jaggery produced was too sticky and dark. No spirit is made in the district from the jaggery as the Mahua flower (Brassica) is an abundant and cheap source for the manufacture of spirit. A syrup made from these flowers is also used in mixing with tobacco for the *hukkah*.

Cultivation.

9. The planting season lasts one month from the beginning of the bright half of *Vaisakh*, that is, the month of May. The earlier in the month of May, the better, as hot moist climate which conduces to good development, prevails at the time. Planting before and after May is not considered good.

The harvesting season lasts about 7 weeks from the first week of February to the end of March. If cut later, the people think that the jaggery will be very liquid. Labour is dear at the reaping time, but if cut early, the cold season interferes with the formation of jaggery. At this time labour is employed in cotton picking, watching castor, *tur*, etc.

10. The following rotation is generally practised:—

(1) Fallow, with rabi castor or brinjals at very wide intervals to allow of repeated ploughings; or a green manuring crop of *san* (only lately introduced).
(2) Sugar-cane.
(3) *Kodra* mixture, including *tur*, *til* and *sheria*.
(4) *Bajri* mixture, including *mug*, *math* and other pulses.
(5) *Kodra* mixture.
(6) *Bajri* mixture followed by fallow.

So sugar-cane comes again after the 6th year and it is not considered good practice to take another irrigated crop in the interval.

The cane is never rotated with rice and attempts to grow it in *Kyari* land have failed, resulting in stunted growth of the cane on account of these lands being lowlying and water-logged. In the cane field no catch crops are taken and no mixed cropping is practised. People grow *tur*, castor, *val*, and other vegetables of the cucurbitaceæ order on the outskirts to utilize the moisture, but they never grow sorghum as a trap crop, for moth borer Maize as a trap crop has recently been introduced since last year and efforts are being made to extend the practice.

11. Ratoon is never practised probably on account of the white-ants and other diseases.

12. Before setting-in of the monsoon, previous to the cane crop, about 25 tons of well rotted cattle manure per acre are applied to the land and ploughings begin with the first fall of rain. Sheep folding is also practised if available. In all 20 or 22 ploughings with the indigenous plough are given while the land is kept fallow throughout the rainy season and the winter, wide intervals being left between the plants of the fallow crop for this purpose.

13. On removal of the fallow crop, the land is well ploughed and made even, furrows and ridges are formed, and beds are made. Each bed contains at least 4 ridges and is $12' \times 10'$ each. Water is then allowed to pass in the furrows, and soon after sets of cane each having 3 eyes are put in the furrows in a line and pressed with the foot nearly 4 to 5 inches deep. Each furrow contains nearly 10 sets.

14. As there is an intervening period of from 2 to $2\frac{1}{2}$ months between harvesting and planting in the middle of the hot season, the canes intended for seed have to be kept standing and irrigated. On this account it has been the practice of some villages to grow cane only for seed and all the others buy the seed from them. There is also a belief that seed brought from a place where well water is a little saltish gives a good yield. The result most often is that a man has to buy even diseased seed or go without it.

15. Sets from all parts of these standover canes are used, those from the middle portion being considered the best. The rooting lower portion of the cane is rejected and there is no special belief one way or the other about tops.

16. No solutions are used for dipping the sets against diseases; people do not seem to believe in such preventives.

17. The number of sets per acre for planting is from 18,000 to 22,000 sets, each having 3 eyes. 20,000 is considered average, more sets being planted in poorer and less in better class of soils.

18. Planting in rows is considered better as it facilitates digging between the rows. The distance between the individual sets is generally from 4 to 6 inches and the distance between the rows themselves nearly one foot. The planting and reaping seasons are not at the same time as said before, and the depth to which the sets are put is nearly 4 inches. The soil is light and free and does not retain moisture for more than 5 to 6 days. Again at the time of planting the weather is very hot and withering of the sets is possible if planted less than 4 inches deep.

19. Ryots are not in the habit of supplying vacancies and do not consider it feasible as no sets can be preserved for more than 4 to 6 days. The practices of keeping extra sets in pits or of planting the outskirts too thickly are unknown.

20. The system of making seed beds for canes is unknown here as there is no uncertainty as regards the supply of water.

21. Stool-planting is not practised and has never been known to be practicable.

22. Irrigation is the all-important item in the cultivation of cane. When people think that the supply of the underground current of water may be weakened they never attempt the cultivation. The only mode of irrigation is from wells by native methods of using leather *Kos* and rope. People understand the superiority of using oil-engines in preference to *Kos* and an individual or two have set up the plant on their wells, but the initial investment is too great to venture and the supply of water in many of the wells is not sufficient for a full day's pumping. Cane is irrigated every 6th day except in the four months of the rainy season, when, if the rain holds off for more

than 8 days at a time, the cane requires watering. Cane lands being sandy no draining is necessary.

23 The object of the after-cultivation are to destroy weeds and to conserve moisture. In a period of 2 to 3 months the canes shade the ground and the after-cultivation ceases. Cane crop is weeded 20 days after planting and after putting castor-cake top dressing (1,000 lbs.), the whole field is dug with a spade. Again after 15 days the above-mentioned processes are repeated. Thus 4 to 5 weedings and as many diggings with a country spade are given in 2 to 3 months' time. After the canes have reached 4 feet high permanent furrows and ridges are made and nothing is done after that except giving waterings at regular intervals. The process of weeding is of course very deep and thorough.

24. The system of manuring has already been explained. The essential idea is not only to apply well rotted manure, but to give it time enough for a thorough mixing with the soil and oxidation, &c, as a safety from white-ants which are believed to be fond of fresh manure. The place of artificial manures is taken by castor-cake which is applied in two top dressings of thousand lbs. each. The cake is broken into rough powder and it is either applied plant by plant or put in bags and placed in the water channel. The water easily dissolves it and distributes it evenly. Trash is burnt after the crop is removed and believed to remove the ill-effects of the heavy irrigation and to act as a manure for the next crop in the rotation.

Manurial experiments:—Manurial experiments carried out for several years with locally available manures have shown that an application of 20 cart-loads of dry night soil per acre can well replace 25 tons of farmyard manure and 2,000 lbs. of castor-cake. Experiments with artificial manures are now in progress.

25. Stripping of old leaves does not exist as it is believed to scorch the canes and expose them to the attacks of jackals.

The practice of tying the canes with lower leaves is prevalent instead, as that is believed to prevent the canes from falling and lodging and affords some safety against jackals.

Another method resorted to for guarding against animals is to build a mud wall all round the plantation. But this is done only by careful cultivators in places where few other cane fields exist. People are too religious to kill them.

26. Watering the cane crop just before cutting is universally prevalent.

It tends to increase the quantity of juice and withholding water before cutting is said to spoil *gur* and make it sticky.

36. The yield of cane in Baroda is from 50,000 to 60,000 lbs. per acre and the yield of jaggery is from 6,000 to 7,000 lbs. per acre.

Naosari District.

The cultivation of cane in the Naosari District is the best in the whole State. It is intensive and the people seem to possess a good knowledge of the cultivation of cane and the manufacture of *gur*.

2. The average rainfall in Naosari is 43 inches, distributed in one monsoon period from June to September. The average temperature is 47° mean minimum of January and 102° mean maximum of May and the atmosphere is warm moist with sea-breezes.

The cultivation is practised from ancient times and no recent introduction has been heard of in any part.

4. As in Baroda Division, the area under cane has been considerably reduced since the last famine and the subsequent bad years. The capital of the cultivators has been greatly reduced and the water in wells has gone low and in some cases turned saltish. The area in 1905-06 was 1,044 acres against 1,704 acres before the famine.

The cultivation is not uniform. In some parts, for instance, cane is rotated with rice and is grown in *Kyari* land having embankments, and where cane of a particular variety called Malbary which stands water-logging to some extent is grown. In others, other varieties of cane as Khajuri, Rati, &c., are grown in ordinary black soil called *Talia* land having no embankments, where cane is rotated with *tur*, castor, beans, &c., which will be considered later on. This

Talia land is a loam of a rather clayey nature and retains moisture splendidly.

5. The following varieties of cane are grown :—

(1) *Malbari*—a white variety with plenty of juice.
(2) *Kajuri* or *Surti*—also a white variety but moderately juicy.
(3) *Rati* or red variety moderately juicy.

There are sub-divisions of *Rati* as *Kali Jadi* having a darker appearance, *Kharedi* having stripes, *Goli* having a lighter colour, and *Rati* proper.

(4) *Vansi*-white, very thin, hard, and with little juice.

People having very humble means and thus not affording money for seed of superior variety of cane grow *Vansi*—the poorest variety.

Gandi Sherdi is another variety of *Vansi*. There is a cane called *Mani* which is believed to be poisonous. When small-pox prevails, some low caste people dedicate it to the goddess to cure the sick This cane is only found grown in the courtyards of houses of lower people.

Of all those canes, *Khajuri* is the softest and *Vansi* the hardest.

6. *Malbari* cane was introduced some 75 years ago from Bassein and it is believed to be an original Mauritius variety. This variety is taller, thicker, heavier and produces a more abundant crop than all the rest. But it has since been deteriorated both in weight and juice. However it is still considered best amongst all the varieties mentioned above.

No cases have been reported of local canes having been exported.

7. The varieties named *Kharedia* or *phus-bhuri* having stripes and *Kali Jadi* are believed to be sports from the red variety. In cane fields flowers do appear at times, but no seeds are formed and hence no seedlings.

8. The State tried to produce sugar in a sugar factory and the results have been noted under manufacture. People used to manufacture spirit from flowers of *Mahua* tree (Brassica) and from the scum of boiled juice, but these practices have ceased to exist since the manufacture of spirit has been considered illegal.

Cultivation.

9. The planting season begins soon after the rains have ceased and it lasts for two months, October and November, and should cease when cold season begins to set in.

The reaping time lasts for 8 weeks, from the beginning of October to the end of November, and lasts up to the end of January for late varieties. Thus eleven months are believed to be sufficient for ripening. But this period differs with different varieties of cane; thus *Malbari* ripens first, then comes *Rati*-red variety and next comes *Khajuri* and lastly comes *Vansi* in maturity. *Rati*, *Khajuri* and *Vansi* can stand for 12 or 13 months, not so the *Malbari*. At the reaping time labour is dear, being employed in cutting rice, grass, *Kodra*, &c. It runs as high as 6 annas a day with food and little of cane juice.

10. The following rotation is generally practised in *Kyari* lands:—

(1.) Sugar-cane after rice is cut.
(2.) Rice in the rainy season and beans (*Val*) in the Rabi season.
(3.) Do. do. do. do.
(4.) Do. do. do. do.

So sugar-cane comes on the 5th year again and the land gets manure every year.

In other lands the following rotation is practised :—

(1) Sugar-cane.
(2) *Tur* and coarse rice.
(3) *San* and after ploughing in the *San* plants, castor and beans as *Rabi* crops.
(4) *Udid* and *san* ploughed up.

So sugar-cane comes again on the 5th year. The cane field is manured in the year in which *San* and *Udid* are grown.

People thoroughly understand the value of *San*, *Tur*, *Udid* being leguminous plants in the rotation and of the green-dressing of *San* and *Udid*. No irrigated crop is taken in the interval. Tobacco is sometimes grown as a catch crop in the beginning, but this is considered bad practice. People grow vege-

tables of the cucurbitaceæ order on the outskirts to utilize the moisture, but they never grow sorghum as a trap crop.

11. Ratoon is generally not practised and in some trials by cultivators the resulting crop had been a failure, the plants having been withered.

12. In *Kyar* land, manure is applied evey year. In the cane year, after the rice is cut, nea rly 10 ploughings with the native plough are given and the land is made level with the *samar*.

In the *Talia* land previous to the cane crop, about 25 tons of well rotted cattle manure per acre are applied in the month of May and ploughings begin with the first fall of rain. Sheep folding is also practised if possible. In all, 20 ploughings and in some places even 25 ploughings are given and a crop of *San* and *Udid* is sown. After it has reached some height it is ploughed up and the land is made thoroughly even. It is believed that the greater the number of ploughings, the lesser the amount of irrigation required. People know the value of tank-mud and put it on the land whenever they can.

13, 14 & 15. After bringing the land in good heart, whole canes are planted with a very heavy plough called *Nangar* drawn by from 6 to 8 bullocks. By this plough, canes are laid in the soil fairly deep, *viz.*, 6 to 9 inches. The bullocks are driven in a circle round the field and canes are laid underground in concentric furrows. Three to four men drive the bullocks according as the number of bullocks are (6 or 8); one man passes the canes in the tube in the *Nangar* and one man hands over the canes to the former. Thus in the planting operation 5 to 6 men are employed.

Whenever the crop is without diseases, people are in the habit of keeping a portion for seed. Otherwise they purchase seed from the neighbourhood. This is easy as harvesting and planting are practically done at the same time. Tops are not considered good for seed.

16. The people do not seem to believe in dipping the canes in any solution against diseases.

17 & 18. The number of canes used as seed for one acre is 1,750 whole canes having the length of 6 cubits each. If the canes are longer or shorter, the number varies accordingly. Generally speaking there is a tendency to plant too many rather than too few. People prefer whole canes to sets as they want to plant them deep in the moist under soil and save irrigation for at least 2 months after planting.

19. If vacancies occur, canes of inferior quality which can be had a month after planting are planted by hand. Seed canes are planted within 2 days after cutting.

20. Seed beds or nursery are not in vogue.

21. Stool planting is not practised and has never been known to be practicable.

22. Irrigation is necessary but more or less according to the nature of the soil and the ploughings given to it. The crop is irrigated either from wells or tanks. The soil is very retentive and not many waterings are needed. Thus in certain lands on the banks of rivers where cane fields are kept fallow a whole year before planting and ploughed throughout to conserve moisture, the first watering is given three months after planting and in all 5 to 6 waterings only are given. No watering in the monsoon and after the rains have ceased, one more watering before harvesting is given. At other places 10 to 12 waterings in *Kyari* land and 15 to 20 in *Talia* land are needed. The water in wells is not plenty and no oil-engine will get work for a full day's pumping. Two oil-engines with pumps have been set up by people on rivers and water is pumped for sugar irrigation for the owners' fields as well as sold to neighbours.

23. The object of the after cultivation is to conserve moisture. No weeding is done, as there are few weeds.

Nearly 20 to 25 days after planting, land is ploughed keeping the share shallow so as not to touch the canes below with a view to loosen the surface. Another month after, the land is dug and watered. Such diggings and waterings continue till the following June when they cease with the arrival of monsoons. The objects of digging between furrows are to keep down weeds, to loosen the surface and to cut the surface roots of the cane.

24. The system of manuring has already been explained. The essential idea is not only to apply well rotted manure, but to give it time for a thorough

mixing with the soil. The practice of green-dressing with *san* is universal and the place of artificial manure is taken up by castor-cake. People are not very particular about giving cake, and in *Talia* soil many people do not put it. Whenever it is applied, it is given at the rate of 1,600 lbs. per acre and in monsoon only with a watering. It is believed to stimulate the growth of cane and to kill white-ants. People believe that the application of cake is a safety against water-logging.

25. The practice of burning trash exists but no green-dressing after the canes are planted.

Stripping of old leaves does not exist as it is believed to scorch the canes and expose them to the attacks of jackals.

Similarly, canes are not tied and neither bamboo nor any other thing is used as a precaution against lodging or for straightening. A hedge of castor plants and thorns is made round the field and the fence is covered with fisherman's net against jackals and other wild animals. In the centre of field, a raised platform is made and a figure resembling a man with a bow and arrow is erected upon it to frighten the animals. *Vansi* has a very hard rind and is not touched by jackals, so it is planted round the field as a protection for the main crop. Some men hire the services of some low class people who keep hounds and thus get the jackals destroyed. Beating of drum is also practised, but is of no avail.

When the canes are very young, rabbits destroy the shoots and a watchman is kept throughout night with fire by his side

26. Cane is watered 8 to 12 days before cutting as watering cane immediately before cutting is believed to make *gur* sticky and increase the cost of fuel.

36. The yield of cane in Naosari is from 45,000 to 60,000 lbs. and of jaggery is from 5,600 to 7,000 lbs.

Amreli Division.

The cultivation of cane in the Amreli Division of the Baroda State comes last in importance from all the rest.

2. The average rainfall is only 20 inches distributed in one monsoon period from June to September. The average temperature is 60° minimum and 107° maximum and the mean is 89°. The atmosphere is warm for the greater portion of the year tempered with sea breezes.

3. The cultivation of cane is known from ancient times and no recent introduction has been heard of in any part.

4. The area under sugar-cane was being gradually reduced even before the great famine, but the reduction has been heavy since the famine which has reduced the capital of cultivators and the water in wells and increased the attacks of white-ants. The area in 1905-06 was 150 acres against 934 acres before the famine. The cultivation of cane comes only once in 12 years and the crop is irrigated from wells. The cane soil is dark coloured and is fairly deep derived from Kathiawar trap rock.

5. Two varieties of cane are cultivated, one red variety with hard rind and the other white variety with soft rind. The white variety is richer in juice and yields more *gur*. However white cane is not much planted as its seed is very costly and requires a richer soil and wants more irrigation. Of the white variety there are two kinds :—*Dhokadiya* thick and having short internodes, and *Vansada*, having long and thin internodes. Of these two, *Dhokadiya* is considered higher as it weighs more and produces more *gur* than *Vansada*.

A good white cane weighs from 10 to 20 lbs. each and the red one from 5 to 7 lbs. each.

6. It is believed that the white variety of cane has been introduced some 100 years ago from Mahua port in Bhavnagar territory, but ultimately from the Konkan coast. This white variety is spreading but the red variety, though poor, will not disappear as it is believed that a soil upon which the white variety has been once grown will not produce sugar-cane next time until after 25 to 50 years, as it is very exhausting.

7 Sports have been found in canes. Sometimes stripes of yellowish or white colour have been found in red cane. In white canes though no change

of colour is visible the internodes become smaller. Such sports are believed to be sweeter than the original canes.

Similarly, flowers have appeared on individual plants of the white variety but no seeds are formed and consequently no seedings have resulted.

8. In the District no Sorghum nor palm nor any other plant are used for making *gur*.

Similarly no spirit has ever been produced from the scum or any other thing. The whole tract is treeless and hence palm or Brassica are few there. Beet was once grown by a curious cultivator, seeds having been supplied by the Department. According to his opinion the roots were large and well developed but no attempt could be made to make sugar out of it.

Cultivation.

9. The planting season begins after the cold season is over and it lasts for one month in the whole of March. The harvesting season lasts about six weeks from the middle of January to the whole of February. At the harvesting season, labour is dear as cotton picking and wheat cutting are in progress. The white cane ripens a bit earlier, say a fortnight. If allowed to stand longer it would be hollow and the *gur* will be decreased.

10. The following rotation is generally practised :—

Sugar-cane.
Bajro and *Mug*.
Cotton and *Udid*.
Jowar and *Mug*.
Bajro and *Mug*.
Cotton and *Udid*.
Jowar and *Mug*.
Bajro and *Mug*.
Cotton and *Udid*.
Jowar and *Mug*.
Bajro and *Mug*.

Fallow with *til* ploughed up in September.

Thus sugar-cane comes again after 12 years, and no irrigated crop is taken in the interval. But as said before, white sugar-cane is not grown on the same soil except after a very long period, say 25 to 50 years. Cane is never rotated with paddy. *Mug* is sown broadcast and then cane is planted. This is considered a good practice, as *Mug* plants are considered a protection of the cane against sun. *Mug* plants are not dug up in the soil but are cut up and fed to bullocks and the roots allowed to rot in the ground.

On the outskirts castor and vegetables of the cucurbitaceæ order are grown to utilize the moisture. Similarly *okras*, *guar*, watermelon, &c., are grown on the water channels for green vegetables, but sorghum as a trap crop is never grown. There is a practice of sowing *Bajri* along with *Mug* with a belief that *Bajri* plants will act as a preventive against rabbits who will eat them as they are soonest cut.

11. Ratoon is not practised. It is believed to be unprofitable as the resulting crop is much attacked by diseases and there is a good deal of foliage and not much of cane stem.

12. The land is kept fallow and ploughed throughout the year. In all, 20 to 25 ploughings are given. With the arrival of the rains, *til* is sown and ploughed up in September. The plough is used in the hot and cold seasons, while in the rainy season only *karab* is used.

No manure is used except just before planting the cane sets. There are cases where people do not keep the land fallow, and after removing the monsoon crop, the land is ploughed 4 to 6 times and cane is planted though on a small scale. The soil can be ploughed at any time and no puddling is necessary. Manure is put on the soil after the land is well ploughed and ready for planting canes. Nearly 30 tons of cattle manure or village manure along with, are applied to the land. Sheep folding is practised wherever practicable. As people are in the habit of burning cattle dung owing to scarcity of firewood, it is largely replaced by village manure which is of a very poor quality.

13. When the land is well ploughed and made level, beds are formed and manure is put and spread on the top of the beds. Then the beds are filled up to the brim with water and one man standing in the beds with cane sets, each having three eyes, in a hanging cloth behind his back, throws the sets in two rows at a time and presses them with his feet alternately. He tries to throw sets in rows judging by the eye but generally the sets are not in perfect line as is the case in Baroda. The rows are one foot apart.

14 & 15. Cane takes nearly 11 months to ripen and sometimes crushing and planting are carried on simultaneously. Whenever this is the case, tops and lower portions are set apart for planting as they are considered bad for making jaggery, and the rest of the canes are crushed. As a practice, a portion of the crop is kept apart for planting and the rest is crushed. Whenever one month elapses between planting and crushing all parts of the cane are used for seed, but as said above, tops and lower portions are preferred when both the processes are carried on at the same time.

16. No solutions are used for dipping the sets against diseases. People do not seem to have heard of such practices.

17. The number of sets per acre is from 20,000 to 25,000, more sets being planted in poorer and less in better class of soils. The sets are pressed some 6 inches deep as sets pressed less deep are liable to wither.

18. Vacancies are never supplied, and canes are never kept purposely but planted soon. In an emergency, however, 8 to 10 days elapse before cut canes are planted. In such cases canes are kept in shade and water is sprinkled over them.

20. The system of making seed beds for cane is unknown as there is no uncertainty as regards supply of water.

21. Stools are not planted but they are considered good for planting.

22. Irrigation is the most important point in cane cultivation. When it is feared that the supply of underground water is weak, people do not attempt the cultivation. The usual mode of irrigation is from wells by *Sundhia Kos* and rope Since leather became very dear after the famine, a kind of iron bucket locally manufactured has been introduced and an iron bucket with a leather trunk is considered the best. In the southern part of the District, the Persian wheel is used. Irrigation is continuous throughout the period of growth every 8 to 10 days, except when it is actually raining. The rainfall being small, a day after the rain ceases the crop is irrigated. The land is naturally drained. Oil engines have in no place replaced the *Kos*, as the wells generally are small.

23. No digging or hoeing is attempted or is possible as the sets are not in perfect line. In all, 4 weedings and stirrings of the soil with a *Khurpi* are done after *mug* plants are cut up in June, and up to September when the cane shades the ground and weeding is impossible.

Bajri plants which are planted as a protection against rabbits are taken off in April.

24. The system of manuring has already been explained. As cattle dung is burnt as fuel, as is to be expected in a treeless country, village manure generally of a very interior kind is used. Unlike the system in other places, manure is spread on the ground after the thorough cultivation is finished. The place of artificial manure is taken by castor cake. It is not always that castor cake is applied, but when the crop looks poor and yellow, it is applied as a top dressing only once in September at the rate of 500 lbs. per acre.

25. No practice exists to burn trash and no green dressing applied after planting. The catch crops are taken off in June and July.

The stripping of old leaves does not exist as they are considered a protection against wild animals. The disease called 'salo'—insect boring into the stem—is believed to increase its attacks by stripping the leaves. The practice of tying the canes with lower leaves is prevalent instead, as that is believed to prevent the canes from falling and lodging and thus from putting adventitious roots. No bamboos are used to support the canes, but several canes are tied up together by a string.

26. The practice of guarding the canes against jackals and other wild animals are :—

(1) Bamboo trellis is made round the cane crop and the thorns of *bor* (zuzuba) are put round it.

(2) People engage the services of *Vaghari*, Mahomedans, &c., who keep hounds to kill them. These *Vagharis* put a pot in which pieces of bread and *gur* are put in the run of jackals and when they come they are destroyed. This latter practice is not very general.

(3) Beating of tin boxes is practised, but to no purpose.

In spite of these expedients the damage done is very great.

Paragraph Nos. 27 to 35 are common to all the districts.

27. The cultivation of cane is not only expensive but is considered to be most risky due to various diseases

28. Diseases affecting sets—

White ants destroy them and jackals eat them up.

29. Diseases affecting the whole plant—

Kasdo—the growth is arrested and the cane turned into a tuft of leaves. This is rare and occurs in poorly manured fields of low class cultivators.

Koylo—This is a fungus disease, as a result of which the top turns into a black powdery mass.

Ratdo—Red rust.

Borer.

30. Diseases affecting the underground parts—

A large white little grub over an inch in length and with an orange red colour.

White ants

Root parasite—called *agio*.

31. Diseases affecting the stem—

Mealy bugs.

32. Diseases affecting the leaves—

Weavils, flea beetles, some caterpillars and scale insects (*mashi*), the last being the most important.

33. *Harvesting.*—When the rind gets yellowish and the top leaves concentrated and tufted the cane is considered to be ripe for cutting.

34. Cut and striped canes are not allowed to remain uncrushed for more than a few hours, and people know that the juice becomes acrid if cut cane is kept uncrushed for a longer period.

35. The cane is cut very low, a little below the ground, with a hand *khurpi*, the roots, leaves and tops being removed at the same time.

36. The yield of cane is from 40,000 to 60,000 lbs. and of jaggery is from 5,000 to 7,000 lbs.

Manufacture.

37. *Mills.*—In Baroda two roller wooden mills are used. The rollers are over a foot in diameter and have corresponding screws in the top part for motion. In Naosari wooden rollers are being gradually replaced by three roller iron mills of Poona type, the rollers being placed side by side. The cane is fed between rollers 1 and 2 from one side and fed for repressing between 2 and 3 from the other side. In Amreli two roller wooden mills are used but the rollers are thinner and larger than the Baroda rollers and there is a greater space between the rollers necessitating repressing a greater number of times.

The percentage of juice to cane varies so much between cane and cane and also among the roller mills of the same type that no general average can be given.

The juice is collected in a large round earthern pot wider at the top than the bottom. This pot is sunk in the ground near the mill in Baroda and Amreli and beyond the bullock run in Naosari. The juice passes through a bamboo sieve into this pot. The pot is big enough to hold juice for one charge of the boiling pan which averages 50 to 60 gallons.

The juice is not kept standing for any length of time, but removed to the boiling pan by *chattis*. The removal of juice gives time for changing bullocks and rest to the workers at the mill and after a little more rest the crushing begins again. Crushing cane for one charge takes a little less time than boiling and the work is continuous. The juice is poured into the iron pan through a basket which serves the purpose of straining.

The boiling pans are shallow, evaporating pans about 7 inches deep in Baroda and Amreli and a little deeper in Naosari.

Megass is used everywhere for fuel but it is not quite enough and it has to be supplemented by tamarind twigs and *tur* stalks in Baroda and by thick *Jowar* stalks in Amreli and Naosari.

The juice is not allowed to boil till the scum comes up. The scum is then removed and the fire increased. During boiling also any little scum that may come up is removed. In Baroda the scum is thrown into the oven. In Naosari it was formerly used in making spirit for the labourers, but is now thrown away as spirit making is now illegal, while in Amreli it forms part of bullocks' feed. Fine white ash is used for cleaning the juice in Baroda and ash and Soda-bicarbonate are used in Naosari and Amreli. Liming is not done in any part.

The correct point for stricking a pan is determined by taking a little of the mass between fingers and drawing out the threads. Cooling iron pans are used in all places. The boiling mass is removed to these pans and worked for a time with flat wooden ladles till it is sufficiently cool and consolidated. In Baroda round pits are made in the ground each large enough to hold the full charge of a pan. The pit is lined by a piece of cloth and the mass thrown in and covered over. The jaggery settles hard in a day and is removed. The weight varies with the quality of the cane and juice from 60 to 100 lbs.

In Amreli the boiling is a little harder than in Baroda and the mass is removed from the cooling pan on to *a leeped* floor and divided into small masses of about 6 to 10 lbs. each, and worked into shape by hand. In Naosari, the pan is struck a little softer and after working in the cooling pan the jaggery is poured into earthen pots which are covered over and sealed.

These are the forms in which the jaggery is put on the market. In Baroda and Amreli, it is sold by weight of jaggery while in Naosari by weight of the full pot, and a fixed deduction is made on account of the pot. On account of this system, pots are being manufactured with a very heavy bottom.

No process of preservation is either used or necessary as the jaggery in these forms can be kept without deterioration.

The prices realised by the cultivator vary from Rs. 7 to 10 per pucca maund in Baroda, Rs. 6 to 9 in Amreli, and Rs. 4 to 5 with pots in Naosari, one-sixth being deducted for the pot while it may actually weigh into a third

The markets being usually fully stocked according to requirements, there are no heavy fluctuations in bazar prices.

In Baroda, local jaggery is the heaviest priced lot; it is not enough to meet the demand and jaggery is imported from Naosari, Poona, Sangali and Cawnpore.

In Amreli also the local demand is higher than the supply and jaggery is imported from Naosari and Cawnpore.

Naosari exports jaggery to Gujarat and Kathiawar and even to Bombay in addition to supplying local demand.

The pots for export are weighed by professional weighers and the weight scratched on the pots by nails. This weight is accepted wherever the jaggery goes and whole pots change hands.

38. The following is the profit and loss account on sugar-cane cultivation:—

Expenditure per Bingha.

	Rs.	As.	P.
20 ploughings, a pair of bullocks and one ploughman, one rupee per day	20	0	0
10 *Karabing*	10	0	0
Manure-cartage and spreading 15 tons	22	8	0
Ridging, making water channels, beds, &c., one bullock and six men at 4 annas each	2	0	0
Castor cake, 1,200lbs.	15	0	0
Value of sets	30	0	0
Carrying sets and planting them, 4 bullocks per 6 annas and 6 men per 4 annas each	3	0	0
Hand weeding 6 times, 10 labourers each time at 2½ annas each	9	6	0
Digging 4 times, 4 men each time at 4 annas each	4	0	0
Putting castor cake plant by plant 2 times, 2 men at 4 annas each	1	0	0
Making new furrows and ridges once, 3 men at 4 annas each	0	12	0
Tying canes once	2	0	0
For crushing and cutting canes, 13 men at 4 annas each and 6 pairs of bullocks at 8 annas a pair for 15 days	93	12	0
Hire of cane-crushing mill and pans	7	8	0
Fuel	10	0	0
Irrigation from wells for 6 to 7 months when there is no rain, four waterings each month, five men and four bullocks	70	0	0
TOTAL	300	14	0

So there is expenditure of nearly Rs. 300 per bingha and Rs. 525 per acre. We get from 150 to 175 maunds of *gur* (maund=40 lbs.) per acre and one maund fetches Rs. 4 to 5, consequently the income from one acre is from Rs. 600 to 900.

39. No careful analysis has been made of the canes and juice but the variation in the quality of the juice can be gauged to some extent by the pan results in Baroda, where the same volume of juice, *viz.*, 55 gallons from the same variety of cane gives in different fields and even in different parts of the same field, *gur* varying from 60 to 100 lbs.

40. *Sugar-making.*—No native process of manufacturing is in vogue in any part of the State. The central factory system was introduced in Gundevi in the Naosari District by the State, where cane was brought from the cultivators and sugar made direct. This however did not pay and refining of palm jaggery had been added. The factory has recently been sold and it is being re-arranged for working sugar-cane in the season and refining palm jaggery throughout the year. The failure of coarse jaggery to compete with palm jaggery for refining purposes is probably due more to its first cost than a smaller percentage of crystallizable sugar. Palm jaggery can be brought from all the way from Malbar and carried in the factory at Rs. 100 per ton against Rs. 120 to 150 per ton, the price of local jaggery.

Imported sugar.—Three kinds of sugar are imported, beet, Mauritius and Java cane, and Bengal dabhota (*khand*). The first which is cheapest is used for all general purposes, the second for sweets in which milk forms a part, and the last which is the dearest is used for sweet balls at large caste dinners. All crystal sugar is locally called *Morus* (Mauritius) and although it is believed to be not so sweet as dabhota or jaggery it is slowly gaining ground on account of its cheapness.

Improvements.

Direction of improvements.

Manuring.—Some cheaper manuring that would give an equal effect and release the local manure for other crops.

Irrigation.—This forms the largest part of the improvement in sugar-cane cultivation.

Seed.—In the Baroda District seed difficulty is great and some system of preserving cut seed for two months without deterioration will not only save the cost of seed but also check a great lot of diseases which come with the sets.

RAOJIBHAI B. PATEL, M.R.A.C.,

Director of Agriculture.

APPENDIX I.

PAPERS ON VETERINARY MATTERS.

SUMMARY OF OPINIONS RECEIVED FROM VARIOUS OFFICERS.

Curtailment of grazing grounds.

Lieutenant-Colonel Raymond says :— Bengal.

I have consulted the District Officers of Bengal and their reports go to show that the curtailment of grazing lands has taken place, more or less, in almost all the districts of this Province. This is attributed chiefly to the extension of cultivation due to the gradual increase of population and partly to other minor causes—such as construction of railways and dwelling-houses, encroachment of lands by mill-owners and brick-manufacturers, etc. Some District Officers report that the curtailment of grazing lands has caused deterioration of the cattle, while others report that, although a certain amount of grazing lands has been utilised for other purposes, there is still sufficient waste land for grazing purposes. In some districts sufficient pasture lands have been set apart during the settlement operations and protected by law against encroachment, while in others they are not diminishing owing to the gradual decrease in population of recent years, and are not likely to diminish much in extent in the immediate future. Little or no land has been absorbed by the extension of irrigation work. The Conservator of Forests, Bengal, reports that there has been practically no change in grazing arrangements in the Bengal forests for over 20 years, and there is nothing to show that the forests which are now closed to grazing were ever largely used for that purpose, or that their closure has affected one way or another the breeding of cattle. The Deputy Commissioner of Darjeeling, on the other hand, contradicts this statement by saying that his district appears to be eminently fitted to illustrate in a striking manner the gradual tendency of the Forest Department to bring, within its reserve, lands which hitherto afforded sufficient space for cattle to graze on.

None of the District Officers have been able to state definitely to what extent the grazing lands have been curtailed during the last 20 years and what encroachment is likely to take place in future. It is, however, apparent that there is a general tendency towards the encroachment of grazing lands and it is probable that it will continue if steps are not taken to check it.

The measures suggested by the District Officers for the preservation or extension of grazing lands are—

(i) The reservation of existing grazing lands by legislation.
(ii) Owners to be prohibited from leasing out their grazing lands to the tenants for crops.
(iii) The zamindars and land-holders to see that a fair share of their land is always preserved for grazing purposes.
(iv) The existing grazing lands should be demarcated and the Local Officers should be directed to report further encroachment, which must be disallowed. Also a register of existing grazing lands might be maintained in the district and sub-divisional offices.
(v) The preservation of lands for pasturage may be effected through the agency of the new Chaukidari Union System by reserving lands for a convenient group of villages, if Government gives the power to do so by some legal enactment.
(vi) Reafforestation by the Forest Department.

My own opinion is (Lieutenant Colonel Raymond's):—

That encroachment in Bengal of grazing land proceeds steadily owing mainly to equally steady increase of population and to the demands of commerce ; the absorption of grazing land is inevitable, but may be regulated,

retarded and controlled by carefully considered legislation. If, however, the population continues to increase, grazing, except on a small scale and on fallow land between crops, is doomed, for it must give way ultimately to land hunger.

There is yet time to work out remedies and I think they will be found in the study by the Agricultural Societies of forage crops and the simplest method of storage of forage. I am inclined to suggest that these subjects as well as the further consideration of legislation are perhaps ripe for systematic study in Bengal.

The subject of water-supply in very dry seasons appears to be an important one.

United Provinces

For the purpose of this enquiry the provinces fall into three divisions, the submontane districts, Bundelkhand, and the rest.

In Bundelkhand, cultivation has contracted during the last 20 years, while the grazing-grounds of the breeding-tracts consist either of ravine-systems (which tend naturally to extend), or of hill sides and valleys which are not suitable for cultivation. There is therefore no question as regards this tract.

The rest of the provinces show no extension of cultivation during the last 20 years. There was not then, and there is not now, any breeding industry in them. People who can afford it keep cows for milk and the male progeny is reared for field-work; but the extraordinary diversity of the type of cows renders it practically impossible to do anything to help this form of breeding. In this tract there are, with local exceptions, no regular grazing-grounds; the extensive barren plains are used as exercise-grounds, but by December any grass that may have grown is usually grazed off, and for six or seven months they afford no feed at all.

In the remaining tract (submontane), considerable curtailment of the grazing-grounds is undoubtedly in progress. It is not due to canals, as none exist, while the additions to forest area during the period specified are immaterial. It is the normal result of the progress of the country; the land is almost entirely in private hands and its owners find that cultivation pays better than grazing.

The question of securing sufficient grazing land to save the great breeding industry in these tracts has at my instance been referred to a small committee for enquiry during the present cold weather. Pending their report, it is unnecessary to say anything further on this point.

Mr. Oliver, Officiating Superintendent, Civil Veterinary Department, submits a detailed report on this subject as affecting each important district. From which it will be observed that of 38 districts reported on, it is said that although the cultivated area has increased, no noticeable decrease of grazing grounds has taken place in 22 districts, nor are the cattle reported to have suffered.

But in the remaining 16 districts, the reduction in the area of pasturage has told severely on the cattle.

Bombay Presidency.

Mr. Hewlett, Superintendent, Civil Veterinary Department, Bombay, states that as regards grazing grounds the conditions of the Presidency vary in different parts. In Gujrat there is no flow irrigation and no lands reserved by the Forest Department other than genuine forest areas—the Godhra forests, for instance. Grazing grounds are, at present, adequate in the Ahmedabad district—as well as in the districts of Broach and Surat. In the Konkan, including Thana, Kolaba and Ratnagiri, there has been no curtailment of grazing grounds, which is amply sufficient. In the Karnatak, Belgaum, Bijapur, Dharwar and Kanara districts some diminution has taken place in the last 20 years by waste lands—formerly used for grazing—having been brought under cultivation. In the Deccan there is but little grazing. The majority of land is under cultivation and affords very little grazing of any description after the middle of November. In parts of Khandesh there is still ample grazing as also in the vicinity of the Ghats. In Nasik, the grazing area has diminished and is likely to diminish still more in the future owing to keen competition for waste lands for cultivation purposes. In Ahmednagar, Poona, Sholapur and Satara there has been little or no diminution of grazing grounds.

Is of opinion that the Forest Department is in the best position to arrange for the conservation of grazing areas, by preserving their Kurans and forests, as far as possible, for grazing purposes, and not with the object of attempting to grow forests where none have existed and where the more valuable varieties of timber cannot be grown. Some of the grazing grounds belonging to the Forest Department are sold, for grazing purposes, by public auction. Mr. Hewlett thinks that, if possible, this system should be discontinued as it introduces the middleman. Suggests that either the Forest Department collect grazing fees of 2 to 4 annas from cattle owners, or, if this is not practicable, to give the villagers of the villages adjoining the Kurans, &c., preference at the auction sales

Mr. Howlett is of opinion that except a few favourable localities, the majority of districts in the Bombay Presidency are not specially suited for cattle breeding.

Sind, Baluchistan and Rajputana

In Sind, large areas of land have been, are being, and will be brought under flow irrigation; but as these areas were, more or less, waterless deserts, their being brought under the plough will not effect pasturage for cattle. Reservation by the Forest Department has not caused diminution of grazing grounds as the Forest areas are available for grazing on payment of a small fee.

Fodder crops are the main feeding stuffs of Sind cattle; therefore increased irrigation and consequent increased yield of fodder crops makes up amply for any diminution of grazing areas.

In Baluchistan there are 234 square miles of reserved forests, of which 69 square miles are available for grazing. In some districts the diminution of grazing grounds is severely felt by the people, especially in the Quetta District.

In Ajmer-Merwara, (Rajputana) grazing grounds are stated to be sufficient if the rains are good. There has been no increase of forest reserve for the last 20 years, and no encroachment on grazing grounds by cultivation.

Mr. Hewlett states he is not sufficiently acquainted with the districts to warrant his offering an opinion or making any suggestions.

The Collector of Sukkur (Sind) informs Mr. Hewlett that the want of suitable grazing grounds is leading to a deterioration in the stamp of camels bred in Sind. Increased irrigation has brought under cultivation much land that was formerly waste and on which any number of camels could graze without restriction.

Punjab.

Captain Walker submits copies of correspondence with the Director of Land Records and Agriculture, and the Conservator of Forests, and states that the curtailment of grazing grounds during the last 20 years has been great; but has been counterbalanced to some slight extent, by the extension of forests. Recommends for each group of villages, a certain forest reserve, and the grazing rights of these areas to be held by the villages concerned under the usual payment of fees.

Burma.

From Major Evans' report as well as from its enclosures, it appears that there is no curtailment of grazing grounds in Burma Necessary grazing grounds have been provided and demarcated and the boundaries, from time to time, are verified. Persons found encroaching are prosecuted and ejected.

THE PROVISION OF FODDER IN TIMES OF FAMINES.

Lieutenant-Colonel Raymond says :—

Bengal.

Fodder-famine is of rare occurrence in this province. As far as I can see from the Famine Reports of 1873-74, 1896 and 1897, there was never any great difficulty about fodder, as there was enough to feed the cattle with a reduced allowance. The proposals for the provision of fodder, in times of famine, laid down in Chapter XV of the Bengal Famine Code, appear to be sufficient (copy below). The storage of forage in years of bumper crops would, no doubt, render great help in times of famine.

CHAPTER XV.

CATTLE

251. *General.*—It may be noted, as a matter of general experience, that, where possible, it is far more effective to bring fodder to cattle than to take cattle to fodder, and that to keep cattle in a village helps to keep the inhabitants of the village together.

252. *Growth of fodder crops.*—When, therefore, fodder-famine is imminent, liberal advances should be given to the cultivators, with a view to the construction of temporary wells for the growth of fodder crops. The influence of land-owners and others may also be usefully employed, with the object of stimulating the growth of such crops.

253. *Importation of fodder.*—The importation of fodder and other foodstuffs, such as cake, shall be left mainly to private enterprise; but the District Officer shall—

(*a*) assist private enterprise by publishing the fact that fodder is wanted in any tract;
(*b*) give liberal advances for the purchase of fodder; and
(*c*) report to the Local Government for orders any case in which he thinks the State should guarantee the sale of fodder imported.

254. *Report to Local Government.*—When a fodder-famine is imminent in any district, the District Officer shall report the matter, through the Commissioner, to the Local Government, which may, if it thinks that this course is desirable, order that the provisions of the four following sections of this chapter shall be applied.

255. *Levy of fees for grazing in State pasturages.*—In a fodder-famine the preservation of agricultural cattle is a matter of far greater importance than any revenue which might be obtained from grazing fees levied on account of the admission of cattle to State pasturages. If, therefore, such fees are levied at all, they should be imposed on administrative grounds, and not as a source of income.

256. *General principles.*—Areas in which grazing is ordinarily permitted should be thrown open to free grazing, and areas which are ordinarily closed to grazing should be reserved for the supply of grass for export. It may be necessary to supplement the latter by reserving portions of the former areas for grass-cutting; or it may be possible to throw open portions of the latter at once, when the supply is in excess of the demand for export. But, the needs of local cattle being provided for, the supply of grass for export should be the first consideration. When the grass has been cut from the areas thus reserved, they also may be thrown open to free grazing, if necessary. Browsers should not be admitted without payment to any areas which contain forest growth of any importance and should in no case be admitted to areas ordinarily closed to grazing. No grazing should ever be allowed in areas under plantation or regeneration, unless the trees are old enough to be safe from attack.

257. *Restrictions.*—If it is found that cattle are resorting to a State pasturage in numbers greatly exceeding its grazing capacity, it may become absolutely necessary to limit their number. This may be done by restricting admission to cattle of villages in the immediate vicinity of a forest, such villages having the first claims upon its pasture.

258. *Fees to be levied in special cases.*—The cattle of professional graziers and cattle-breeders may properly be charged for grazing, even when agricultural cattle are admitted free.

259. *Cattle Camps.*—When a fodder-famine is severe, a cattle camp may, with the previous sanction of the Local Government, be instituted in each district under veterinary supervision. Only selected cows and a few selected bulls shall be accommodated in the camps, the chief object of which is to preserve valuable breeds. The District Officer may, if he considers this desirable, purchase the cattle admitted to the camp, and at the end of the famine, re-sell them.

260. *Selection of pasturages.*—The Local Government shall, in communication with the Commissioner, the Director of Land Records and

Agriculture, and the Conservator of Forests, determine what areas of Government forest or waste land are, in accordance with the principles enunciated in section 256, available for pasturage in each district which is liable to famine, and what number of cattle can advantageously be admitted to such areas in the event of a fodder-famine. The list of such areas shall be revised annually in the month of January. The orders of Government shall be communicated to all officers concerned.

261. *Register of pasturages.*—From the information received under the previous section, the District Officer shall prepare and maintain a register in Form J showing—

(*a*) the pasturages available; and

(*b*) the number of cattle that may be sent to them.

FORM J.

Register of pasturages and cattle in the District for 190 .

1	2	3
Description and general indication of boundaries of pasturages available.	Number of cattle that may be sent from the district to the pasturages.	REMARKS

The Director of Land Records and Agriculture states :—

United Provinces.

The call made for suggestions on this grave question has had very little result; the suggestions that have reached me are either not new or are obviously impracticable.

A fodder-famine is much rarer in these provinces than an ordinary famine and cannot be expected more than once in 30 years. It would obviously be bad economy to devote cultivated land to meet this emergency as the loss would be greater than the capital value of the stock saved; and apart from this there is no chance of our landholders doing anything of the kind. Something can be done in particular villages if it is found practicable to turn the bare ravines into rough grazing, but this would have a very local effect. Our experience is that fodder-famines are least felt where the practice of stall-feeding is most developed; and all indications point to the conclusion that the best measure to take is the extension of irrigation, which not only minimises the loss of fodder in a drought, but enables special fodder crops to be grown and—more important still—increases the wealth of the people.

As regards utilization of forests, there are certain well-known regions of migration, where the cattle are transferred seasonally according to need. These should of course not be interfered with, but apart from them all recent experience goes to prove that the forest grass should be railed to the cattle—except only in the case (very rare in these provinces) where water is available in the forest and not available in the famine-tract. The Conservator of Forests is at present working out for use in emergencies a table showing the price at which grass can be laid down at each important railway station in the tracts liable to fodder-famine; and this step might possibly be found useful elsewhere.

The large question of storing grass in the forests for, say, a year ahead is one on which I cannot enter for want of data regarding the cost involved and the annual loss in good years. I hope it may be possible to get the Forest Department to experiment on this question on an adequate scale, but I fear that where fodder-famines are as rare as they are with us the process on a large scale would be very costly.

Speaking generally then, the best safeguard in these provinces is the increase of wealth of the cultivators, which extends the local resources; to supplement these, the forests must be utilized to the utmost.

In these provinces, the Civil Officers whose opinions and suggestions were asked by the Superintendent, Civil Veterinary Department, have submitted various proposals for the provision of fodder during famine, *viz.* :—

(*a*) Opening of closed forests for free grazing.
(*b*) Storage of a year's produce to meet demands in a year of drought.
(*c*) Waste land within reach of Canal Water to be reserved for growing grass and be watered free of cost.
(*d*) Minimum area of land be left uncultivated in each village and be planted with such trees, the leaves of which can be used as fodder for cattle.
(*e*) Sale of grass on Government lands, or on lands in possession of District Municipal Boards, to cattle owners.
(*f*) Cutting and stacking hay at close of rains.
(*g*) Railways to carry fodder at rates sufficient to cover cost of haulage.
(*h*) Establishment of fodder reserves by Government and big Zemindars.
(*i*) Takavi advances to cattle owners to purchase grass.
(*j*) Government to purchase cattle, transport them to the forests, and re-sell at the end of famine to the districts from which they were exported.

Bombay Presidency. Mr. Hewlett says he does not think he can give any information or can arrive at any conclusion which is not contained in the Report of the Famine Commission of 1901. The question of the classes of cattle worth preserving in famine camps and supplying them with fodder, are :—Gujarat—Krishna Valley —Khilari—Gir—and the Malvi breeds—also the Jafferabadi and Surati breeds of buffaloes.

Sind, Baluchistan and Rajputana. Mr. Hewlett refers us again to the Report of the Famine Commission of 1901.

Punjab. Captain Walker recommends the establishment of fodder reserves by the Agricultural and Forest Departments. The scheme to be run on commercial principles. Fodder to be supplied on the spot at a moderate price.

Burma. Major Evans states that the trouble in Burma, usually, is excess of water—floods, &c.

Many cattle die from starvation during the rains when the high floods occur, owing to all grazing land having been suddenly submerged. He thinks that the cattle might well have been saved had the people been less indolent, as there was no lack of such fodder as young Kaing-grass and Bamboo leaves, which, in default of better, could have been stored against such a possible contingency.

Should famine occur, forest reserves would be thrown open for grazing. When fodder is short, cattle appear to eat all sorts of bushes. Suggests the planting up of dry areas with fodder bushes that grow in other arid, hot countries.

THE BEST METHODS OF UTILIZING THE SERVICES OF VETERINARY ASSISTANTS, *i.e.*, BY STATIONARY WORK IN DISPENSARIES, BY ITINERATING WORK IN VILLAGES

Bengal. Lieutenant-Colonel Raymond's opinion :—

Though itinerating work is the better at present, the services of both itinerant and stationary Veterinary Assistants are essential. The establishment of dispensaries at the district and sub-divisional head-quarters is very necessary, inasmuch as most of the well-to-do people reside there, and they keep valuable animals, which, when sick, require treatment. With regard to the treatment of village cattle, the services of peripatetic Veterinary Assistants are important. They tour in the villages, advising the villagers how to look after the health of their animals and treating and inoculating the cattle during outbreaks of epizootic diseases. Itinerating men in large outbreaks require assistance from a reserve kept at head-quarters for that purpose. They also require constant supervision.

I am in favour of both systems: they have their advantages and will develop.

On this point Major Maxwell writes as follows:— United Pr :

"I have for some time been of opinion that the best way to get the most satisfactory work out of all Veterinary Assistants would be to have a dispensary in every district, with all Veterinary Assistants of that district attached to it. Only one man to remain at head-quarters at a time, then the dispensary would never be closed, and a man (or men) would always be moving about as Sanitary Officer in their districts. The men could advise as to treatment and get cases sent in to the dispensary. Under the present system there is a great waste of money in supplying two or three sets of instruments and large quantities of medicines for one district, for, as you know, if there were 20 Veterinary Assistants in one district they would all want to have exactly the same things to work with; if one man has a paper of pins all the others will immediately indent. Of course I am aware that at present there are only a few dispensaries in working order, but I would recommend a trial of this system where they do exist. I think it could be so organized that we might find out more as to the individual value of our men as they would all have a turn at both medical and sanitary work, and would not get into such grooves as they now do."

The Director of Land Records and Agriculture states:—

I have not heard of this suggestion before; it seems to me to be well suited to all districts containing three or more Veterinary Assistants, and I commend it as deserving of full consideration. But for the present, when most of our districts have either one or two Veterinary Assistants, its defect is that it would (by retaining one man at the dispensary) weaken the very small force available for fighting epidemics. In these provinces (outside the localised breeding-tracts) the employment of Veterinary Assistants can be justified only by their success as Sanitary Officers, and so long as not more than two men are available in a district, I consider that to fulfil their chief duty they must both be peripatetic. Experience shows that a dispensary which is liable to be closed at irregular times is of very little use, as persons who come and find it closed give it a bad name among their neighbours; and I would avoid starting more dispensaries until it is certain that they can be kept open continuously without trenching on the staff required for handling epidemics.

Mr. Oliver, the Officiating Superintendent, Civil Veterinary Department, points out that, at present, the subordinate Veterinary staff is much below actual requirements; and that as it stands, it would be unwise to withdraw itinerating Veterinary Assistants and place them in charge of dispensaries; but is convinced that as the subordinate establishment is increased, it will be essentially necessary to augment the number of dispensaries in each district.

Mr. Hewlett is of opinion that in each district there should be one stationary man in charge of the Head-Quarter Veterinary Hospital. This man's services could also be untilized in visiting a few neighbouring villages within a radius of, say, 10 miles, and should also be available for emergent outbreaks of contagious disease. Bombay Presidency.

Considers itinerating Veterinary Assistants very useful, if men of the right stamp are available and if they are not given too large an area to tour over. Does not think that such men can do any real good work if he is given a bigger charge than 2 Talukas.

Mr. Hewlett—the reporting officer—records precisely the same opinion as above under the head "Bombay Presidency." Sind, Baluchistan and Rajputana

Captain Walker sends a copy of a note he has prepared at the request of the Director of Agriculture. In this note Captain Walker explains at some length—the formation of the subordinate establishment—the present position—the disadvantages of the present system—&c., &c. Captain Walker is not in favour of itinerating Veterinary Assistants and gives preference to stationary men. Ample reasons and instances are quoted to warrant his arriving at the opinion expressed, and adds:—"Instead of having one stationary Veterinary Assistant at the head-quarters of the district, and one itinerating man in each Tehsil, it is proposed to have a stationary man in each Tehsil, and one itinerating man for the whole district." Full details are given as to the respective duties of the stationary and itinerating Veterinary Assistants. Punjab.

In the note above alluded to, Captain Walker has embodied recommendations as to the best method of obtaining reports concerning outbreaks of contagious diseases, and the registration of the total mortality for the province. Forms of monthly returns and Post Card intimations are attached. Briefly the method recommended is:—

(*a*) At the end of every month all Veterinary Assistants to send copies of their Diaries to the Tehsildar concerned who will forward them to Deputy Commissioners.

(*b*) At the end of every month every Patwari to send a Return of epidemic disease among animals, to the Sudder Kanungo.—

(*c*) The Sudder Kanungo to hand over the Returns to the itinerating Veterinary Assistant who will, after perusal, send them to the Superintendent, Civil Veterinary Department, through the Veterinary Inspector.

Burma.

Major Evans lays great stress on the necessity of Veterinary work in Burma being, in the first instance, directed towards the suppression of contagious diseases among cattle. He states that, in his opinion, Dispensary (stationary) Veterinary Assistants would only treat such cases as might be brought to them; they certainly would not seek for work. He further adds:—

"I personally would have every man I could on district work. I can see no real advantage to the bulk of cattle owners in maintaining Dispensary Assistants; in fact, I think it would be necessary for them to seek cases here (Burma) to make a decent show of cases treated."

Note on Veterinary Matters, by the Director of Land Records and Agriculture, United Provinces.

(*a*) Curtailment of Grazing Grounds.

For the purpose of this enquiry the provinces fall into three divisions, the submontane districts, Bundelkhand and the rest.

In Bundelkhand cultivation has contracted during the last 20 years, while the grazing grounds of the breeding tracts consist either of ravine-systems (which tend naturally to extend) or of hillsides and valleys which are not suitable for cultivation. There is therefore no question as regards this tract.

The rest of the provinces show no extension of cultivation during the last 20 years. There was not then, and there is not now, any breeding industry in them. People who can afford it keep cows for milk, and the male progeny is reared for field work; but the extraordinary diversity of the type of cows renders it practically impossible to do anything to help this form of breeding. In this tract there are, with local exceptions, no regular grazing grounds; the extensive barren plains are used as exercise grounds, but by December any grass that may have grown is usually grazed off, and for six or seven months they afford no feed at all.

In the remaining tract (submontane), considerable curtailment of the grazing grounds is undoubtedly in progress. It is not due to canals, as none exist, while the additions to forest area during the period specified are immaterial. It is the normal result of the progress of the country; the land is almost entirely in private hands, and its owners find that cultivation pays better than grazing. The question of securing sufficient grazing land to save the great breeding industry in these tracts has at my instance been referred to a small committee for enquiry during the present cold weather. Pending their report, it is unnecessary to say anything further on this point.

(*b*) Employment of Veterinary Assistants.

On this point Major Maxwell writes as follows:—

"I have for some time been of opinion that the best way to get the most satisfactory work out of all Veterinary Assistants would be to have a dispensary in every district, with all Veterinary Assistants of that district attached to it. Only one man to remain at head-quarters at a time, then the dispensary would never be closed, and a man (or men) would always be moving about as sanitary officers in their districts. The men could advise as to treatment and get cases

sent in to the dispensary. Under the present system, there is a great waste of money in supplying two or three sets of instruments and large quantities of medicines for one district, for, as you know, if there were 20 Veterinary Assistants in one district they would all want to have exactly the same things to work with; if one man has a paper of pins all the others will immediately indent. Of course I am aware that at present there are only a few dispensaries in working order, but I would recommend a trial of this system where they do exist. I think it could be so organized that we might find out more as to the individual value of our men as they would all have a turn at both medical and sanitary work, and would not get into such grooves as they now do."

I have not heard of this suggestion before; it seems to me to be well suited to all districts containing three or more Veterinary Assistants, and I commend it as deserving of full consideration. But for the present, where most of our districts have either one or two Veterinary Assistants, its defect is that it would (by retaining one man at the dispensary) weaken the very small force available for fighting epidemics. In these provinces (outside the localized breeding-tracts) the employment of Veterinary Assistants can be justified only by their success as sanitary officers, and so long as not more than two men are available in a district I consider that to fulfil their chief duty they must both be peripatetic. Experience shows that a dispensary which is liable to be closed at irregular times is of very little use, as persons who come and find it closed give it a bad name among their neighbours; and I would avoid starting more dispensaries until it is certain that they can be kept open continuously without trenching on the staff required for handling epidemics.

(c) Provision of Fodder in Famine.

The call made for suggestions on the grave question has had very little result: the suggestions that have reached me are either not new or are obviously impracticable. A fodder-famine is much rarer in these provinces than an ordinary famine and cannot be expected more than once in 30 years. It would obviously be bad economy to devote cultivated land to meet this emergency as the loss would be greater than the capital value of the stock saved; and apart from this there is no chance of our landholders doing anything of the kind. Something can be done in particular villages, if it is found practicable to turn the bare ravines into rough grazing, but this would have a very local effect. Our experience is that fodder-famines are least felt where the practice of stall-feeding is most developed: and all indications point to the conclusion that the best measure to take is the extension of irrigation, which not only minimises the loss of fodder in a drought, but enables special fodder crops to be grown and—more important still—increases the wealth of the people.

As regards utilization of forests, there are certain well-known regions of migration, where the cattle are transferred seasonally according to need. These should of course not be interfered with, but apart from them all recent experience goes to prove that the forest grass should be railed to the cattle—except only in the case (very rare in these provinces) where water is available in the forest and not available in the famine-tract. The Conservator of Forests is at present working out for use in emergencies a table showing the price at which grass can be laid down at each important railway station in the tracts liable to fodder-famine, and this step might possibly be found useful elsewhere.

The large question of storing grass in the forest for, say, a year ahead is one on which I cannot enter for want of data regarding the cost involved and the annual loss in good years. I hope it may be possible to get the Forest Department to experiment on this question on an adequate scale, but I fear that where fodder-famines are as rare as they are with us the process on a large scale would be very costly.

Speaking generally then, the best safeguard in these provinces is the increase of wealth of the cultivators, which extends the local resources; to supplement these, the forests must be utilized to the utmost.

APPENDIX J

Note on Agricultural Engineers by Sir Edward Buck, K.C.S.I., LL.D.

Attached to my Report on the utilization of silt is a note by Professor Giglioli, Principal of the Agricultural School at the Milan University, in which it is explained that Germany was the first to train a corps of Agricultural Engineers, that France followed the example and that the agricultural leaders in Italy are anxious to do the same. The position in these countries was, as it is still in Italy, much the same as that which existed in India when I came to the North-West Provinces. All engineers in the districts as well as in special departments were under professional direction and control. A step in advance has since been made in placing district engineers under the control of local authorities, their duties being mainly concerned with communications, roads, bridges, &c. They have few functions which can be classed as agricultural.

The fact remains, however, that we have in India what they had not or have not in the European countries, an existing machinery. We have not, that is to say, to create a corps of agricultural engineers. We have only to train an existing corps of engineers (or perhaps I should say the recruits of the future for that corps) in agricultural engineering.

It will be asked what would be the duties of an agricultural engineer as distinct from those of an ordinary professional engineer. The answer does not seem to be difficult. One main duty would be in each district the promotion of irrigation other than canal irrigation, and the execution of works connected therewith. They would have the direction of boring operations; of well construction; of lifts and other irrigating machinery; of the construction of dams and bunds and so on. Another would be the control of surface drainage, with the objects detailed in my report, *viz.*, the utilization of silt and the prevention of erosion. A third duty would be the introduction and general supervision of new agricultural machinery. This would probably involve eventually the maintenance and supervision of district workshops. They could also study the needs of the agricultural population for wood, timber, iron and other material for the construction of agricultural implements, of houses, &c.,—a question which does not appear to come, at present, within the scope of any other department. This duty would include the formation of plantations in co-operation with land-owners. An important duty would also be the maintenance and supervision of the working plan for famine relief which it may be hoped will become more and more agricultural in character and include such operations as the 'doctoring' of ravines; the trenching of fields; the construction of dams and bunds and of temporary wells. This principle is indeed followed in the United Provinces where a working plan for temporary wells is under preparation.

It may be conceived that, as time goes on, a working plan would be prepared for each district not merely in connection with famine relief, but also for the improvement of agricultural conditions in every direction in which engineering assistance is required. Such working plans would require the initial direction of professional engineers in co-operation with the agricultural department of the province. Executive operations of important character would of course also demand the general supervision and direction of professional engineers.

At present, in the north of India, the only class of engineers who are brought into direct contact with agricultural interests are those employed on canals. The ability with which our irrigation works have been constructed, developed, and maintained, has not been surpassed in any country in the world. But it is a question whether the absence of association of the professional engineer with those authorities who are more directly concerned with agricultural interests has not been the cause of occasional incompleteness in results.

The immediate question, *i.e.*, if it is desired to manufacture agricultural engineers, is how they are to be trained. In Italy the suggestion is engineering training first, agricultural education second. It is possible that in India the best course might be agriculture—engineering—agriculture. Boys could be selected from the agricultural school to be sent to the engineering college and return to study higher class agriculture and the practical application of engineering methods afterwards. I will not, however, offer further suggestions. It is essentially a question for discussion by the Board.

I may only add that if selections are to be made from our corps of agricultural recruits the prospects offered them in the engineering line should not be inferior to those open to them in the establishments of revenue administration.

E. C. BUCK.

G. I. C. P. O.—No. 59 I. G. Agri.—7-5-1907—2,075.—D. D'R.